APRIL, 1938

Engineering and Mining Journal

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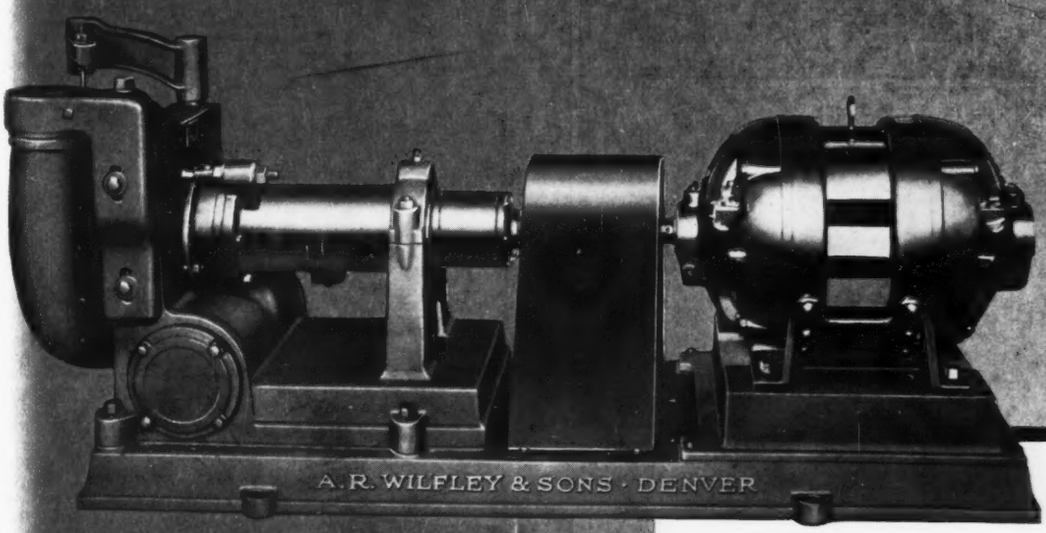

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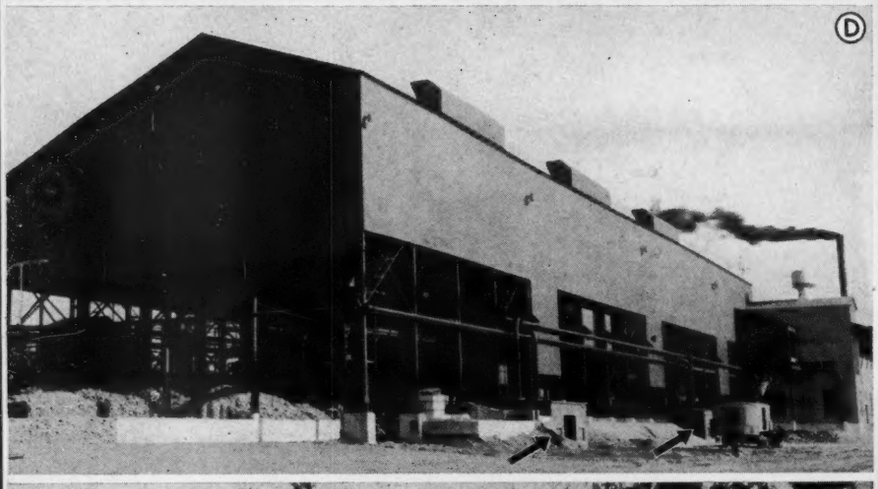

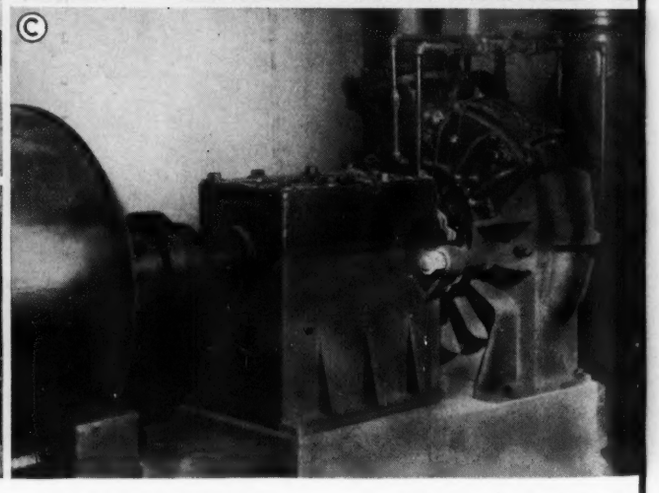

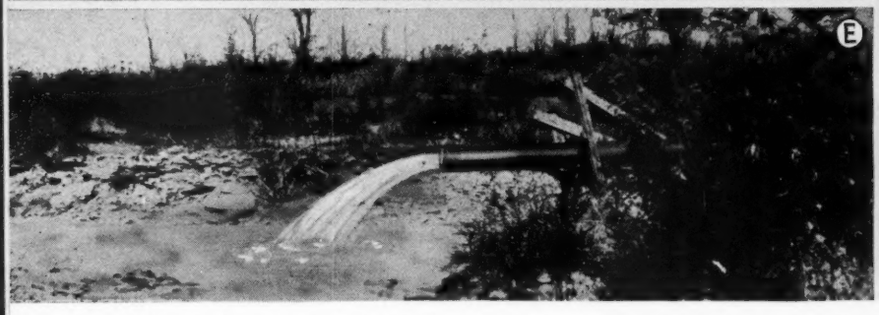

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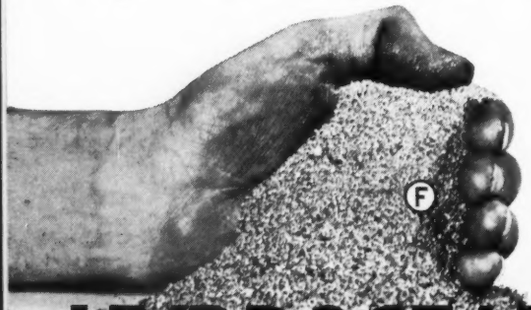

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APRIL 1938

South of the Rio Grande

WHAT NOW IN MEXICO? With the seizure there by the Government on March 19 of the country's foreign-owned petroleum industry, after two years of argument between the operators and the labor union syndicates over wage increases and other benefits demanded for the workers, the question in part is answered as to whether the Cardenas Administration is going to let the syndicates force the expropriation of the country's foreign-owned resources. In regard to the oil seizure, it promises indeed to pay eventually for the properties. The partial answer leaves the mining interests still uncertain as to how far the Government will allow the unions to go in pressing their ever-new demands upon them. What has happened to the petroleum properties may conceivably occur in the case of other mineral resources, although the President has distinctly said that expropriation will not be extended to the mining industry. Mexico as a sovereign nation has of course the right of expropriation within its powers.

A sovereign nation, it is also true, may bow to force of circumstances, and how the circumstances growing out of the petroleum seizure will yet shape themselves remains to be discovered. Already some events that may exert an influence have occurred. On March 28, the United States Treasury decided to defer until further notice its monthly purchases of silver from Mexico as a preliminary to re-examining certain financial and commercial relationships with the Republic; and on the following day the American Ambassador protested officially over the petroleum seizure and asked for reconsideration on the ground that Mexico could not pay the full value of the properties. Only an optimist, indeed, could think otherwise. Ensuing conversations will be long drawn-out.

Narrow Straits

The economic straits in which Mexico now finds itself must inevitably affect profoundly the outcome of events. Mining is the country's most important industry, and the Government has vital need of the funds to be derived from the sale of silver, which have constituted an important part of its total income. To sell the Mexican silver in the London market without depressing the world price to its own great disadvantage will be a notable accomplishment. Following the decision to cease its monthly buying, the United States Treasury lowered its "New York" price to 43c. in two successive 1c. cuts on March 28 and 29, respectively, for what reason one can only speculate as yet. The Treasury disclaims all desire to retaliate. Continuance of the purchasing of silver at the rate of 5,000,000 oz. monthly would result in taking some three-quarters of the country's prospective annual output.

Loss of the dollar balances, moreover, that the sale of silver to the United States Treasury would afford, coupled with the drop in the metal reserve back of the currency to approximately $30,000,000 at the end of March, has led to further devaluation of the peso, the exchange rate being approximately 4.60 to the dollar at the time of writing, compared with 3.60 effective for more than three years past. This tends to restrict imports, accentuating the effect of the greatly increased duties set up a year ago and the advances made in January in decreasing the Government's income from this source.

Further decrease in income for the present will arise out of the very seizure of the oil properties, which are said to have yielded the Government approximately 6 to 7 per cent of the total amount received.

In the face of this immediate cut in income, the demands of the reform program continue heavy, large sums still being needed for the various agrarian schemes, some of which are quite unsuccessful, necessitating increased food imports, and for the large-scale public works that have been undertaken. In recent years, the country's income has indeed been the greatest

in its history, yet the Government has been and is spending more than it takes in and is badly in default on all its obligations. Excess of expenditures above receipts would be less conspicuous were the country's credit good. Unfortunately, the Administration is attacking the very industries from which has come a large part of the funds it needs to carry on.

Aspirations

In considering the aspects of expropriation, one must realize that "Mexico for the Mexicans" is a sentiment widespread in the Republic. Such sentiment is, of course, entirely natural. What it means depends upon the individual expressing it. The spirit of nationalism that it conveys in Mexico is strongest among the younger element, who have come to understand that much of their country's metal output is produced by foreigners, without learning of the way in which this came about or of the huge investment of capital and skill, with the assumption of all financial risk, that has made the successful exploitation of these resources possible. The fact is overlooked that the larger part of mineral ground in the Republic is still in Mexican ownership, private or public. Erroneously the belief holds sway that the mining industry collectively has taken more out of the country than it has put into it. From the popular viewpoint, the recapture of the country's mineral resources is an excellent idea. If the national viewpoint countenances also the idea of payment, in the abstract at least, the questions of when and how and with what are likely to be left for the future to settle.

As in the case of any individual, however, a country that is already in default, and has long been in default, on all its obligations, can hardly expect the new promises it may make to go unquestioned. And if it lacks experience in the task of managing its resources profitably, it will do well to hesitate before burdening itself with their management, especially when it needs its income from them so badly.

An Old Question

As the present régime has warmed to its work in recent years of carrying out its economic program, this question of possible nationalization of the mining industry has always lurked in the background. In pursuing the program's chief objective, which avowedly has been the laudable one of bettering the worker's lot, the Administration has been under pressure by the labor syndicates to go along with them in forcing the companies engaged in extractive work to do their bidding. In all conferences with Labor, whether conducted by local, State or Federal boards, the simple fact that two out of the three members of every board have been pro-Labor at the start, has given the company involved little chance of getting a favorable decision. Upon appeal the company's prospects have been rarely better, for even the Supreme Court is recognized as the instrument of the Administration, its members holding office upon the latter's pleasure. And so, as Labor has multiplied its successes, and its demands have pyramided until they have often seemed fantastic, or nightmarish, frequently tending to take the control away from management, the situation has been incomprehensible unless one assumed that expropriation was the end in view. This assumption is now seen justified. Whether because Labor can no longer be controlled or because there is no desire to exercise control, or it is inadvisable for strategic reasons to do so, the Administration has taken its recent step. Meanwhile, unless conditions have improved since the end of March, labor conditions at the mines are said to have become worse than they were before, if this be possible. Efficiency, long low, has fallen even lower, while workmen stand around and talk and labor committees discuss everything that strikes their fancy. It would not be surprising if, because of the critical situation in which the Government finds itself, Labor were exhorted by the Administration to restrain itself.

Influences at Work

To know the factors that, in addition to Mexico's socialistic tendencies, have helped bring about the present situation, one must look both sides of the Rio Grande. Much emphasized is the fact that some of the petroleum companies are said to have conducted themselves unwisely in the past, through lack of *savoir faire* in pursuing their relations with the Government and Labor. Another element has been the weak representation of American interests by the Embassy at the capital. No doubt, in this Secretary Hull's good-neighbor policy has been a governing influence. But the Secretary himself has said that this policy is a bilateral one. And one should not forget that there may be a point in specific cases where the good neighbor becomes, shall we say, a sucker. The rumor has long been current that Mexican officialdom has often been complimented by the Embassy on its ways of doing things. This perhaps is related to the next factor, which is the effect of the New Deal upon the Cardenas Administration. As was said in our review of February, 1936: "Various parallels of circumstance on the two sides of the Rio Grande suggest themselves. And while the people to the south entered upon their present career long before the spring of 1933 they have since surely received encouragement from what has come to their eyes and ears from across the boundary." This

encouragement by example has continued well into 1938. Indeed, the recent utterances of Mr. Roosevelt as to what should be considered proper compensation for the oil companies which have suffered expropriation must surely be encouraging. The parallel cited ends when one compares the resources of the two countries. Whereas Washington has had, if anything, too ample funds with which to work, Mexico has been cramped for money for carrying out its various measures of reform.

The Outlook

What lies ahead for mining? Despite the pessimism of some executives, the future seems a little brighter. Any attempt to operate the oil industry ought to be instructive if carried out. Difficulties experienced may curb the eagerness of those radicals who would go still further. Need for keeping the mines producing is now even more important than before. And diplomatic exchanges, now in progress, may conceivably bear fruit. All these possibilities yield some encouragement for the industry. The outcome of the petroleum situation will be awaited with interest. If effective payment for the properties is impossible, the Government must surely return the properties, and, if this is done, expropriation will have proved impracticable.

One thing is certain: new investment by foreign capital, which has long since dried up, will undoubtedly remain dried up. Present conditions naturally offer no inducement. Mexico will be fortunate indeed if she can weather the months ahead in harmony.

Off With His Head!

THE TREATMENT accorded by the President to Arthur E. Morgan, chairman of the Tennessee Valley Authority, should give pause to engineers in public service under the New Deal. Evidently one may differ with the Chief Executive only at the peril of being pilloried, browbeaten, and arbitrarily removed from office. This is not the grand maneuver of a master strategist, which is the rôle customarily attributed to the President. Rather it recalls the peevish Queen in Alice in Wonderland whose favorite remedy was decapitation. Nor will it satisfy the public, which is now more certain than ever that the record of the TVA should be thoroughly aired. For Arthur Morgan is a man of unquestioned integrity and sincerity, exceptional ability, and eminent standing in the engineering profession. His refusal to submit to star-chamber proceedings and his demand for a Congressional investigation must strike a responsive chord in many an engineer's mind and lend credence to the belief that TVA affairs need the bright light of publicity.

Break in Silver

FOR MORE THAN NINE MONTHS, from June 10, 1937, to March 28, 1938, the World price of silver in the New York market was uniformly 44.75¢ per troy ounce. On the latter date the price was reduced one cent, and a like reduction followed on March 29. Inasmuch as the New York market is governed by the price the Treasury will pay for other than newly mined domestic silver, the reductions naturally followed the action of the Treasury in successively lowering its bid price. This, in turn, was coincident with the Mexican crisis which led our Government to "re-examine certain of its financial and commercial relationships with Mexico," and to "defer continuation of the monthly silver purchase arrangements with Mexico until further notice." This phase of the subject is discussed in detail on another page.

Considering the stability of the New York silver market for so long a period, plus the fact that our Government's silver purchase policy is still in effect, it is unlikely that any change in the price would have occurred at this time but for Mexico's disturbing action in expropriating the petroleum industry. The incident illustrates the delicate and complicated adjustment of international relations and the world-wide repercussions of an arbitrary act. Oil is expropriated by one country, and the world price of silver falls two cents per ounce. Moreover, the break was the signal at home for a fresh attack on the Silver Purchase Act, coupled with expression of the pious hope that the Government would soon abandon completely a plan that it has not seen fit to consummate, if indeed it were possible. No one can foresee the ultimate outcome of these events, but anyone can see the need of a high order of statesmanship in solving amicably the problems they create.

Minerals in Eastern Europe

BRIEF REFERENCE was made in the Washington news in our March number to the mineral resources of the small countries of Eastern Europe that lie in the path of Germany's expanding sphere of influence. Since then Austria has been absorbed into the Reich, and Czechoslovakia has begun to feel the political pressure of Hitler's power. The logic of the latter drive, from Germany's point of view, becomes apparent when one recalls that some of the mining districts of pre-War Austria and Hungary are now in Czechoslovakia and are consequently viewed by Germany with paternal eyes. The mineral resources of Hungary, Rumania, Yugoslavia, and Bulgaria are also supposed to be attractive and important factors in Hitler's plans for industrial expansion. A

large part of their mineral trade is already transacted with Germany. Nevertheless, it is inferred by informed observers that Hitler is likely to prefer domination and control to the ordinary import-export relations between his country and the Balkan States.

Austria's magnesite, graphite, talc, and lead are now within Germany's domain and add substantially to her national wealth. Little except bauxite is to be gained from Hungary, because her territorial losses after the World War deprived her of most of her developed mineral deposits and left principally some low-grade coal and iron mines. Since 1932, however, bauxite has become of real importance, and Hungary now possesses one of the largest reserves of that mineral in Europe. Czechoslovakia's post-War inheritance makes her an important producer of lead-zinc-silver ores, uranium and radium, feldspar and magnesite, with Germany as her principal export customer. Rumania has large reserves of petroleum and gold, for which France, Germany, and Czechoslovakia are in competition. Yugoslavia also ranks high as a mineral producer in Europe, having substantial deposits of lead, copper, bauxite, chromite, and manganese. Bulgaria, on the other hand, is relatively unimportant as a producer of non-ferrous metals or non-metallic minerals.

This is only a sketchy outline of the mineral resources of Eastern Europe, the political control of which has shifted with the fortunes of war and may undergo still further change. Those who are interested in greater detail will find an excellent source of information in the first number of the Foreign Minerals Quarterly of the Economics and Statistics Branch of the Bureau of Mines.

Assessment Work Should Be Performed

FOR TOO MANY YEARS past Congress has exempted holders of unpatented mineral claims from performing annual assessment work to the value of $100 per claim. Originally waived during the World War so that able-bodied men might serve the Government, the requirement has been nullified by Congress year after year, until exemption has come to be regarded by claim holders as a vested right. There was some excuse for the policy during the depths of the depression; but for the past two years, at least, the feeling has been growing in the Congress itself that the customary assessment work should be required.

As the matter now stands, claim holders are exempt from assessment work until June 30, 1938. But when the bill was passed in June, 1937, it was clearly intimated by members of Congress that this was the last concession. So it behooves claim holders to prepare for their assessment work this summer if they expect to hold their claims. No hope should be placed in a last-minute change of Congressional heart, nor should the duty be postponed until unforeseen circumstances make compliance with the law difficult or impossible. Fair warning has been sounded.

Indexing an Important Service

ENGINEERING INDEX, that non-profit corporation in which both industry and engineers should find an interest, continues scanning the current technical literature of the world, in order to classify its valuable contents for the benefit of all. Regularly it reviews more than 2,000 periodicals, society transactions, research reports, and government bulletins, brought from 40 different countries and in many languages. For its services its charge is reasonable. To conduct its work it has had to depend on pledges largely, the total thus received or promised since 1934 amounting to only $50,000, almost half of which has been secured from the Carnegie Corporation and the balance from a small group of interested companies and individuals. Clearly it needs more working capital, in turn to build more business that will yield it greater income.

Poor indexing renders relatively useless any library or indeed any volume of a single periodical on its shelves. Much that has been written in the past is hopelessly locked away because of it. This need not be true, however, of the vast body of current technical literature, given an agency, such as Engineering Index, to do the task, if it is supplied with sufficient funds. The Index aids research, prevents much needless duplication. Support for it ought to be readily forthcoming.

HISTORICAL SUMMARY: ENGINEERING AND MINING JOURNAL was founded in 1866 as the *American Journal of Mining*, the title being changed in 1869. Publications with which *Engineering and Mining Journal* has been consolidated comprise: *Coal and Iron Record* (1875); *The Mining Review* (1877); *The Polytechnic Review* (1879); *Mining and Metallurgy* (1902); *the Mining Magazine* (1906); *Mining and Engineering World* (1917); *Mining and Scientific Press* (1922); *Engineering and Mining World* (1932). All rights to the foregoing titles of consolidated publications are reserved by the publisher. . . . . THE FOLLOWING have served as editors in chief of *Engineering and Mining Journal* and its predecessor publications: G. F. Dawson (1866–67); R. W. Raymond (1867–74); R. W. Raymond and R. P. Rothwell (1874–89); R. P. Rothwell (1890–1901); D. T. Day (1901–02); T. A. Rickard (1903–05); W. R. Ingalls (1905–19); J. E. Spurr (1919–27); A. W. Allen (1927–33); H. C. Parmelee (1933—) . . . . THE EDITORIAL STAFF of *Engineering and Mining Journal* comprises: H. C. Parmelee, editor; A. H. Hubbell, associate editor; H. C. Cheilson, W. N. P. Reed, J. B. Huttl, assistant editors; H. H. Wanders, market editor; G. J. Young, consulting editor.

AIR VIEW of LaBine Point looking west along the general strike of the veins. Eldorado mining camp is in the upper center. The topography is rugged and the vegetation sparse

Radium From the Arctic

Eldorado Gold Mines producing salts at the rate of one gram per week—Doubling of output considered

H. C. Parmelee
Editorial Director

FARTHEST NORTH of any mining operation on the American Continent is that of Eldorado Gold Mines, Ltd., at LaBine Point, on the east shore of Great Bear Lake, Northwest Territories, Canada. The pitchblende-silver mines of this company lie approximately in latitude 66 deg. N., longitude 118 deg. W., within 30 miles of the Arctic Circle. Original discovery of pitchblende was made by Gilbert LaBine in May, 1930. In that and the following year, small tonnages of rich, massive pitchblende were mined and sorted by hand, and tested in the Government laboratories at Ottawa. In 1932 the property was equipped with a small power plant and mechanical operations were started. A 50-ton mill was built in 1933. Subsequent operations have been on an increasingly larger scale until at present the mill handles 75 tons of ore per day and a modern radium refinery at Port Hope, Ontario, is producing radium salts at the rate of one gram per week. Plans are now under consideration for doubling this production. The writer visited the mine and refinery in February, 1938.

Operations at Eldorado are unique in many respects. They demonstrate the possibility of mining in remote and forbidding areas which, when proved economically important, are suddenly brought within the boundaries of civilization by means of the airplane and wireless communication. Other means of transportation and communication follow, settlements spring up, the frontier recedes, and hitherto unknown resources are added to the world's wealth.

Geography of the area is shown on map Fig. 1. Edmonton, capital of Alberta, lies 234 miles in an air line south of Waterways, on the transcontinental route of the Canadian National Railways. The two points are connected by a 300-mile railroad, but north of Waterways one travels by water or air. Both routes from Waterways to Eldorado are indicated on the map, the water route being about 1,400 miles. The air route from Edmonton is about 1,000 miles.

Water transportation is used for heavy freight and ore shipment to and from Eldorado. It is available for about three months from midsummer to early autumn. The route is continuous except for a portage of 8 miles on the Bear River and one of 16 miles on the Slave River between Fort Fitzgerald and Fort Smith. Eldorado owns the Northern Transportation Company, operating a fleet of steel power boats and barges. Northbound freight rate from Water-

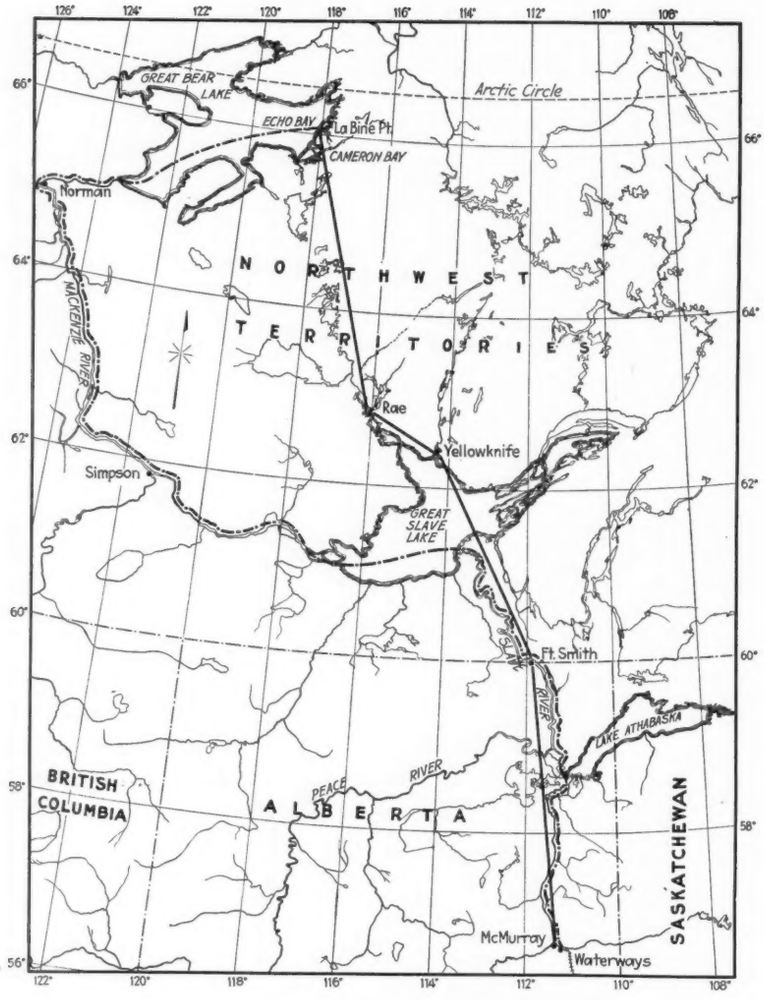


Fig. 1 . . . SKETCH MAP of Northwest Territories

ways to the mine is $110 per ton, a reduction from $240 in 1933. The rate on concentrates southbound is $40 per ton, about one-tenth the cost in 1931. Storage of concentrates is provided at Waterways, from which supplies are drawn by the Port Hope refinery as needed. Transportation distance from mine to refinery is about 4,000 miles.

Eldorado owns a Bellanca airplane, operated by Mackenzie Air Service from Edmonton for passengers, express, and light freight. The cost of air express from Edmonton to Eldorado is 79c. per pound, and for parcel mail $1.25 per pound. Planes are equipped with pontoons in the summer and skis in winter. They do not run during the spring break-up and the autumn freeze-up. Otherwise, flying conditions are excellent. At the mine two gasoline tractors, a Caterpiller 22 and a Cletrac 35, a heated trailer, and the characteristic dog team round out a system of transportation suitable to all needs in a severe climate where the temperature may fall to —70 deg. F. The annual mean temperature is but 17 deg. F. Communication with the outside world is maintained by a private wireless station.

Diesel Electric Power

Isolation of the property naturally suggests diesel engines as the ideal source of power. Fortunately, fuel oil of 18,000 B.t.u. per pound is produced by the Imperial Oil Company from wells on the Mackenzie River, 40 miles north of Norman, a total distance of about 270 miles from the mine. Transportation by oil tankers is supplemented by an 8-mile pipe line over the portage on the Bear River. Storage at the mine is provided for 200,000 gallons. In 1932 the cost of oil delivered in steel drums was $1.11 per gallon, but this has been steadily reduced by improved transportation and handling methods to a current cost of 35c. per gallon.

The power plant consists of four Ruston and Hornsby heavy-oil engines with a total capacity of 834 hp. One of the engines, 177 hp., drives a direct-connected Ingersoll-Rand compressor. The other three, 307, 256, and 94 hp., drive English Electric a.c. generators delivering 3-phase, 60-cycle current at 550 volts for power and 110 volts for lighting. Installed with these engines is a waste-heat boiler receiving the diesel exhaust. Hot water from this source is used in the change and bunk houses, and as feed water for a 60-hp. horizontal return tubular boiler that supplies steam for heating. At the present time wood at $16 per cord is being used as fuel for the steam boiler, but this will be replaced with oil next winter.

Water is distributed through the camp from a 10,000-gal. tank supplied by Dayton Dowd centrifugal and Fairbanks Morse duplex pumps of 6,000 and 2,500 g.p.h. capacity respectively. Fire protection is afforded to all principal buildings from inside hose connections and chemical fire extinguishers.

Unusual problems in management and operation arise from the isolation of the mine, the rugged climate, and the short season of water transportation. Planning must be done a year in advance. Food for more than 100 men, major supplies and equipment for mine and mill, and fuel oil for the diesel power plant must be ordered, shipped, and stored. A well-equipped shop must be provided for repair and maintenance of electrical and mechanical machinery.

Living conditions at the mine are exceptionally good. A central steam-heating plant keeps living quarters and principal buildings at a comfortable temperature in winter, and running water is piped where needed. Steam and water pipes are run on the surface, inclosed in a frame structure heavily insulated with sawdust. All buildings are of modern construction and well insulated. Electric lights, showers, and wash rooms add to the comfort and convenience of the camp. A recreation hall and store are available to employees, and their health is under the supervision of a resident staff physician. The customary food supplies are supplemented by fresh vegetables grown in the Mackenzie Valley, and by seasonal fruits and greens brought in by airplane.

Skilled labor is engaged on a one-year contract, that being as long a time as the management feels a man should remain in camp without returning to the outside world. Wages, in addition to board and room, are $5 a day for miners, $4.50 for helpers, and $4 for general labor. A bonus is paid to underground development crews working on contract. No ill effects have been observed among miners exposed to emanation from radioactive ores. Dust in the mine is minimized by wet drilling and spraying in order to prevent the ingestion by the men of radium itself.

The map of LaBine Point, Fig. 2., shows the location of the mine surface plant, the adit, shafts Nos. 1 and 2, the margin of a granite batholith on the west, the strike and relative position of the principal veins, Nos. 1, 2, and 3. The latter appear to converge at a break in the hills where No.

2 shaft has been sunk. LaBine Point is a low-lying rocky promontory, with maximum elevation of 500 to 600 ft. above lake level, which, in turn, is 350 ft. above sea level. Discovery of pitchblende was made at lake level on No. 1 vein, at the base of an 80-ft. cliff which forms one face of the vein.

Mineralization

A conspicuous feature of the area is the heavy fracturing of the rock, evidenced by numerous breaks or shear zones with brecciated filling. These breaks are unusually pronounced and persistent, being visible from the air and easily traced on the surface. Being more susceptible to erosion than the wall rock, they form depressions in the surface, most clearly defined at the water's edge. Surface indications of mineral deposition consist of weathered stains of uranium, cobalt, copper, and iron.

Eldorado mine lies close to the western boundary of the Canadian Shield. The rocks are fine-grained sediments and volcanics, probably all of Pre-Cambrian age and highly altered by instrusions of granite with which the mineralization is believed to be closely related. A large granite mass extends along the east shore of the lake, appearing on the mainland at LaBine Point.

Mineralization of the area is extensive and varied. In the Eldorado veins the minerals of major economic importance are pitchblende and native silver. Copper as chalcopyrite is widespread, but of secondary value. In addition, at least forty metallic minerals have been identified in Eldorado ores by the Canadian Department of Mines, consisting principally of compounds of iron, cobalt, nickel, molybdenum, bismuth, lead, zinc, and manganese. Pitchblende is regarded as the oldest of the metallic minerals, followed by the iron-cobalt-nickel group, and finally by the copper-silver minerals.

A series of analyses of pitchblende samples by the Department of Mines show variations from 30 to 62 per cent U_3O_8, 5 to 12 per cent lead, and 53 to 1 per cent silica. Corresponding assays for silver were 0.13 and 49.40 oz. per ton. The radium equivalent, calculated on the basis of 3.4 parts of radium in 10 million parts of uranium, ranges from 78.88 to 161.46 milligrams per ton. Most of the lead present is probably the end product of atomic disintegration of uranium.

Three pitchblende-bearing veins have been opened on the property as shown in Fig. 2. They strike northeast-southwest, and dip 75 deg. to 80 deg. north. Most of the mining has been done on vein No. 2, shown in plan and section in Figs. 3 and 4. Here pitchblende occurs in massive, botryoidal form in shoots or lenses varying irregularly in width from small seams to as much as 21 in. The most important gangue minerals are quartz and jasper, although in one zone there is widespread occurrence of calcite, dolomite, and rhodochrosite, with which the greater part of the silver mineralization is identified. Silver is almost entirely in metallic form, ap-

Fig. 2 . . . MAP OF LA BINE POINT, showing location of mine surface plant and veins

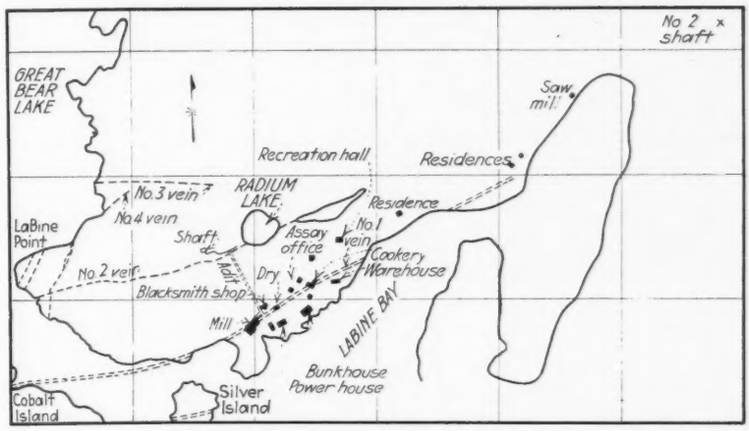


Fig. 3 . . . HORIZONTAL PROJECTION of No. 2 vein

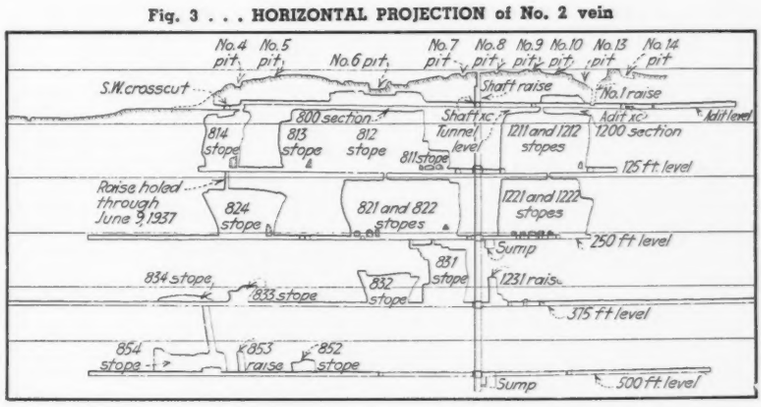
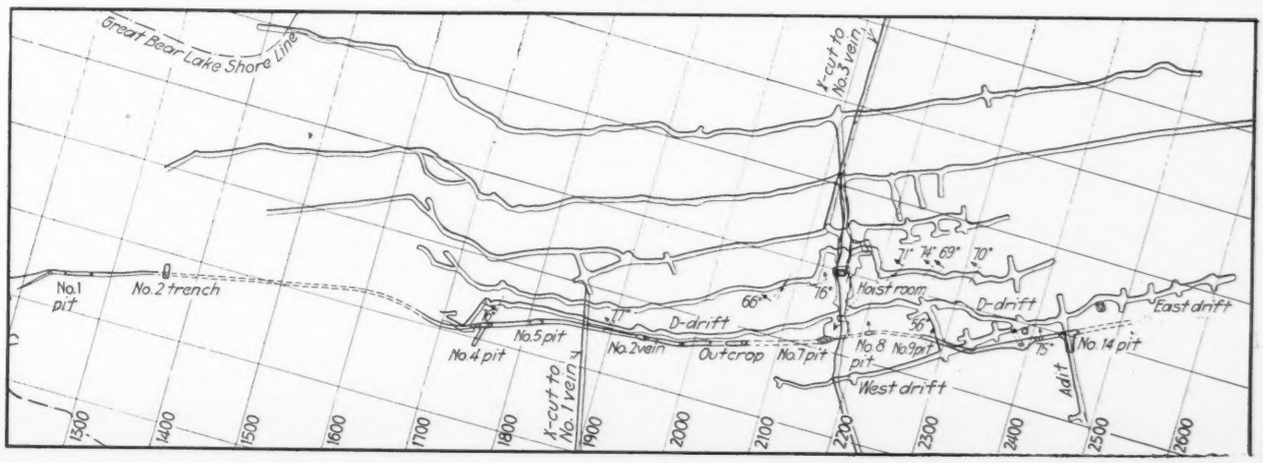
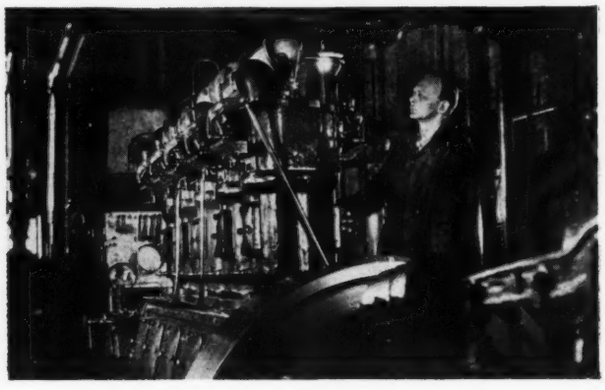


Fig. 4 . . . PLAN of No. 2 vein





1, BARGES and airplanes dock on the shore of Eldorado camp. 2, TRACTOR AND TRAILER invade the Arctic, competing with the more picturesque dog team. 3, SACKED pitchblende-silver concentrates await the opening of water transportation. 4, IN THE DIESEL POWER PLANT. Oil is obtained from nearby wells on the Mackenzie

pearing in the carbonate gangue as wires, leaves, and dendritic growths, and as thick seams in massive pitchblende.

Mining Operation

As shown in Fig. 2, the mine is opened by a 250-ft. crosscut adit to No. 2. vein, on which most of the work has been done to date. Starting in the hanging wall, a vertical two-compartment shaft extends 500 ft. below the adit, with levels at 125-ft. intervals. Shaft stations are 9x12 ft. and drifts and crosscuts 5x7 ft. in cross-section. The ground is usually hard and sound, and it requires little timbering.

Although the veins are quite well defined, it will be observed on Fig. 4, particularly west of the shaft, that they sometimes divide where there is a change of strike, forming offshoots that are temporarily misleading. Drift faces are carefully sampled after every round, and the width of pitchblende and the geology recorded. Electrometer measurements of pitchblende samples are also made in the laboratory to determine their radioactivity relative to that of a sample of known U_3O_8 content.

Stopes are mined by the ordinary shrinkage method, first cutting the back to a height of 17 ft. above the rails and laying a timber floor on stulls spaced at 5-ft. intervals. Chutes are 20 ft. apart. Two cribbed manways give access to each stope. They aid also in ventilation, which is accomplished by a system of raises connecting with the adit level and the shaft raise to the surface. Development and mining costs are given in the accompanying table. Owing to exceptional conditions prevailing at Eldorado, the costs are scarcely comparable to those of other operations.

Special care is taken in drilling to see that a minimum of waste is broken and that holes are not drilled directly into the pitchblende. High-grade ore may occasionally be sorted in the stopes, but otherwise the full width of the vein is broken and sent to the concentrating mill. Close sampling to determine the economic limit of stoping is required only in veins containing ore rich in silver. This occurs principally east of the shaft, which was sunk at about the transition between siliceous and carbonate filling of the vein. The former, to the west of the shaft, is rich in pitchblende and lean in silver. Reverse conditions prevail in the carbonate zone to the east.

Ore reserves, broken and blocked out, are between 55,000 and 60,000 tons, sufficient for two years' opera-

tion of the mill at the current rate of 75 tons per day. About 12,000 tons of broken ore is usually carried in stopes. A large area of unexplored ground remains to be developed between shafts Nos. 1 and 2. The latter has been sunk to a depth of 125 ft., at which level about 400 ft. of crosscutting and drifting have disclosed the presence of pitchblende. Some diamond drilling has been done, but it has not proved very satisfactory for ore development, on account of the irregularity of the ore deposits and the friable character of the pitchblende. This method of exploration is now being used only as a less expensive substitute for crosscutting.

Ore and waste are hoisted in one-ton cars to the adit level, where they are trammed to the mill, the dump, or to a waste pass for filling empty stopes. The hoist is a 75-hp. double-drum unit with an aluminum cage. It is located underground on the adit level in a room about 25 ft. square, with a rope raise 5x7 ft.

Mine water is collected in sumps on the 250 and 500 levels and pumped to the surface. On the 250 level a Smart-Turner triplex pump has a capacity of 125 g.p.m. On the 500 level are two 2-stage Cameron centrifugals with a capacity of 200 g.p.m.

Exceptionally good climatic conditions prevail for the storage of explosives. The temperature is low and fairly uniform, and the atmosphere is dry. Hence no trouble is experienced in satisfactorily storing a year's supply. In fact, powder has been used that has been in storage for two years. Polar Forcite is the preferred brand.

Referring to climatic conditions, mention should be made of the fact that in developing the mine the frost line was found to be about 320 ft. below surface. Considerable difficulty was experienced from frozen water lines and drill machines, ice-covered rails and ditches, and the hanging-up of broken ore in stopes.

Development and Mining Costs

	Drifting Per Foot	Cross-cutting Per Foot	Stoping Per Ton Broken
Labor	$3.568	$3 554	$0 805
Supplies	3 837	3 170	1 098
Power	3 576	3.563	1 032
Hoisting	1 255	1 250	0.283
Steel sharpening	0 329	0 328	0 100
Cookery	1 542	1 536	0.348
Distributed charges	2 647	2.638	0 645
Totals	$16 754	$16 039	$4.311

New Refinery

Nearly completed, and scheduled to be in full operation this summer, is the company's new radium refinery at Port Hope, 60 miles east of Toronto. It is a beautifully designed plant based on the process originally devised in 1933 for Eldorado's pitchblende-silver ore. The essential steps of the process remain as before (*E.&M.J.* Sept., 1937, pp. 39-41) but are arranged in three parallel straight-line units with gravity flow of material.

A new Bethlehem Foundry Wedge multiple hearth roasting furnace of special design accomplishes the first operation of eliminating sulphur. In the successive steps silver is chloridized, uranium is removed and converted into pigments, silver is dissolved and precipitated as sulphide, and radium and barium are separated for fractional crystallization. The final products of the refinery are yellow and orange sodium uranate, black oxide of uranium, and radium bromide.

In concluding these notes the writer wishes to acknowledge the courtesy and hospitality of Gilbert LaBine, president, and Harry M. Snyder, treasurer of Eldorado Gold Mines, Ltd., with whom he visited the mine and refinery. He is also indebted to the technical staff at the mine for their cooperation in furnishing information, in particular E. J. Walli, manager; J. P. Ryan, assistant manager; C. M. Barrett, mine superintendent; and D. A. G. Smith, mill superintendent, who wrote the following account of the evolution of milling methods.

• • •

Milling Pitchblende-Silver Ores At Eldorado Plant

The evolution of the present flowsheet

D. A. G. Smith
Mill Superintendent
Eldorado Gold Mines, Ltd.

PRIOR to the development of the ore at Great Bear Lake little consideration had been given to methods of concentrating uranium ores such as pitchblende. Literature was scarce or entirely lacking, so that, with the erection of a concentrator, methods which were applicable to similar products had to be tried, and rejected or incorporated in the flowsheet according to results obtained.

Concentration as a means of recovering the valuable mineral began as early as 1931, and each year has seen an expanded flowsheet. During the summers of 1931, '32, and '33 high-grade pitchblende and silver from surface pits was hand-sorted and shipped in sacks. This hand-sorting gave an exceptionally high-grade concentrate, but it left a high-grade reject for further treatment.

The first gravity concentrator was erected in 1933 and placed in operation in December of that year. The initial capacity of the plant was 50 tons per 24 hours and the flowsheet was as shown in Fig. 1.

Ore from the coarse bin was passed over a ¾-in. stationary grizzly to a sorting table, where high-grade pitchblende and silver were removed. It was then fed to an 8x12 in. Dodge crusher set at ¾-in. opening. The crusher discharge joined the grizzly undersize on a 14-in. belt conveyor, from which it was carried by a 5x8-in. bucket elevator to a 75-ton fine-ore bin.

The fine ore was fed through a 12-in. H-type wall feeder to a 4x8-ft. Allis-Chalmers rod mill, the discharge of which was carried by a 7x12-in. bucket elevator to a double-deck Allis-Chalmers vibrating screen equipped with 12-mesh and 20-mesh screens. The plus 12-mesh material was returned to the rod mill, the minus-12 plus 20-mesh was delivered by a No. 6 Wilfley table, and the minus 20-mesh material was treated on a similar table.

On the table three products were formed: a concentrate, which was removed to the dryer; a middling, which was returned to the tables; and a tailing, which passed through a conditioning tank to a No. 15 Sub-A two-cell flotation unit. By flotation a silver-copper concentrate was formed and a tailing, which went to the failing pond. It was found, however, that further grinding was essential to increased silver recovery.

By January, 1935, the flowsheet shown in Fig. 2 was in operation with a capacity of 75 tons per 24 hours. The crushing circuit was altered by the

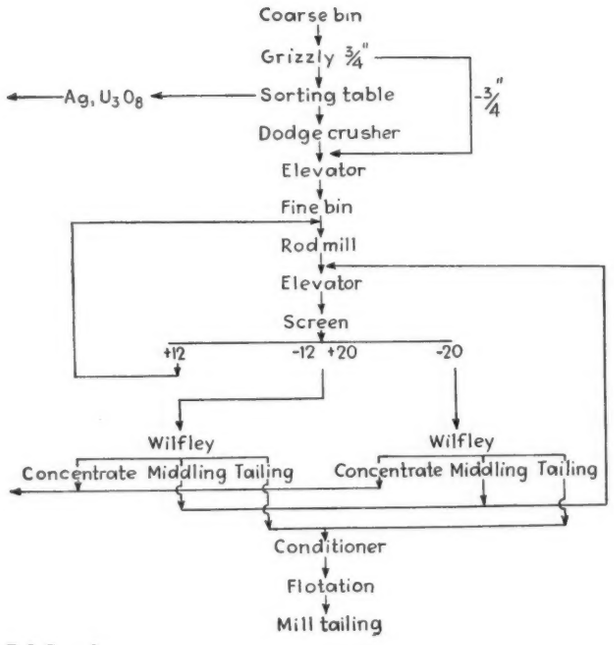


FIG. 1

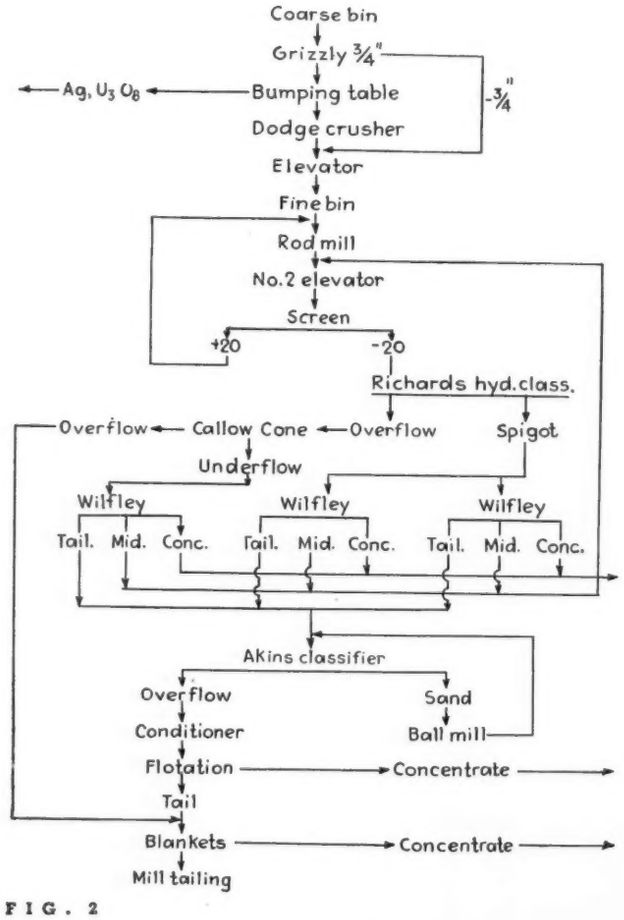


FIG. 2

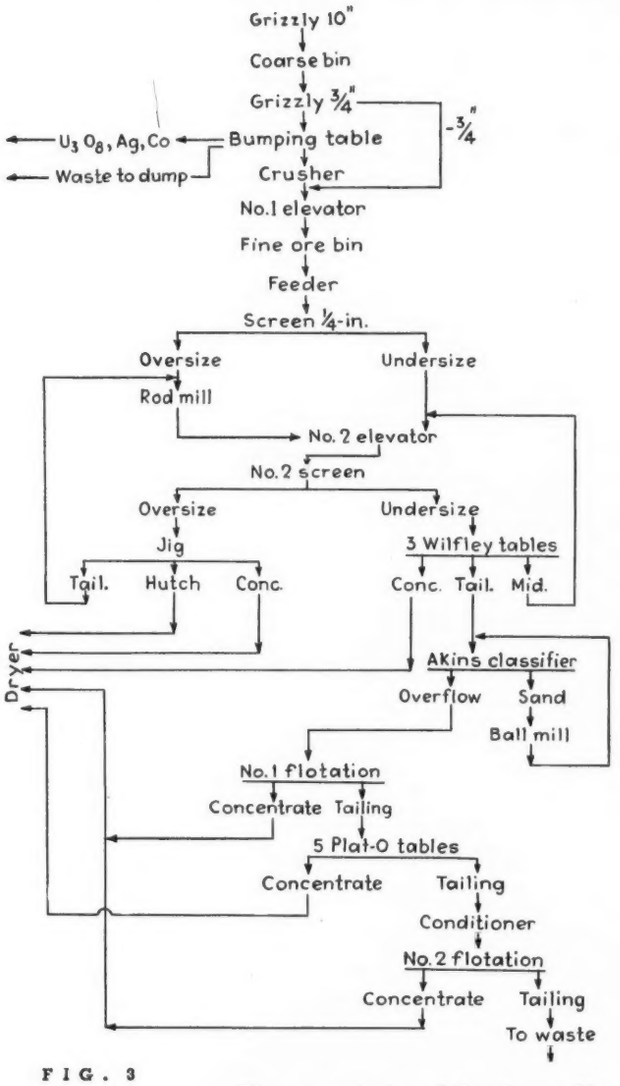


FIG. 3

addition of a 12x3-ft. bumping table actuated by an air-driven Parks Pusher to replace the stationary sorting platform. This replaced the labor in crushing and increased the sorting efficiency.

In the remainder of the circuit, all material was screened on 20 mesh, the oversize being returned to the rod mill and the undersize entering a single-spigot Richard's hydraulic classifier. The spigot discharge was distributed over two No. 6 Wilfley tables and the overflow was sent to a 6-ft. Callow settling cone. Underflow of the cone was treated on a No. 6 Wilfley table and the overflow was treated on blanket tables.

The concentrates of the three tables were combined on the dryer. Middling was returned and the tailing entered a 30-in. Akins classifier operated in closed circuit with a 4x6-ft. Allis-Chalmers ball mill. Classifier overflow was treated in the two-cell flotation unit, from which a concentrate of silver and copper was drawn. The tailing from this unit was treated on blanket tables before going to waste.

In the early part of the year the concentrator was converted into a full-scale experimental station and the pulp flow was altered in as many ways as possible in an attempt to perfect a flowsheet. During this time it was found that, though the blanket recovery of silver was fair, the recovery of pitchblende was negligible; and that better recovery of both might be obtained on shaking tables. The most favorable points in the variations of the flowsheet were combined and resulted in flowsheet No. 3.

Ore from the adit was delivered to a 50-ton coarse-ore bin through a 10-in. grizzly, composed of 90-lb. rails. It was drawn over a stationary grizzly set at ¾-in. opening, through a water spray to the bumping table, from

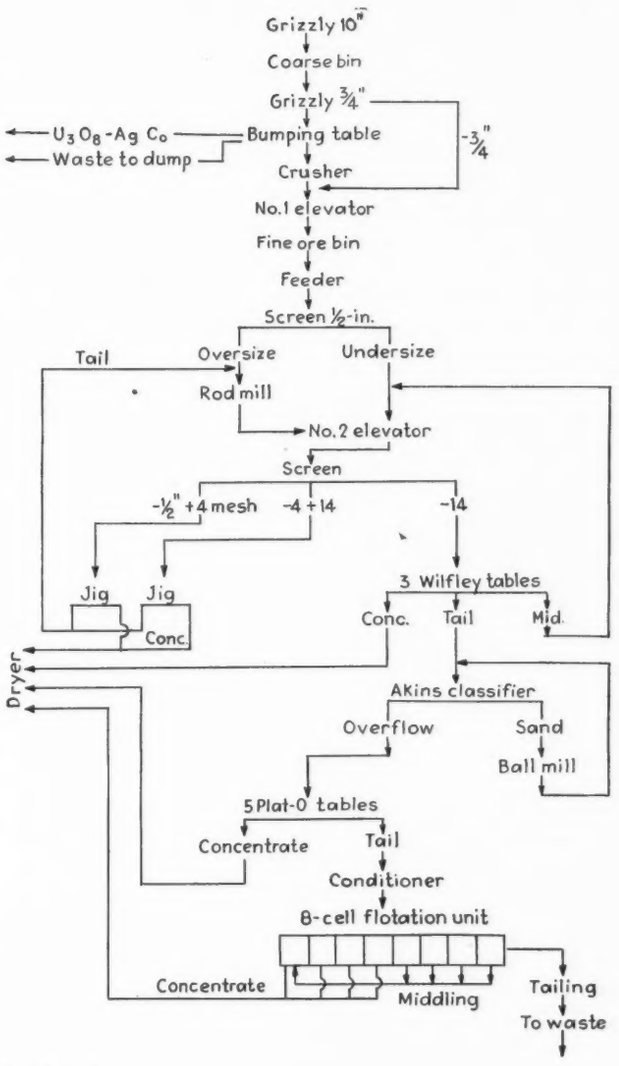


FIG. 4

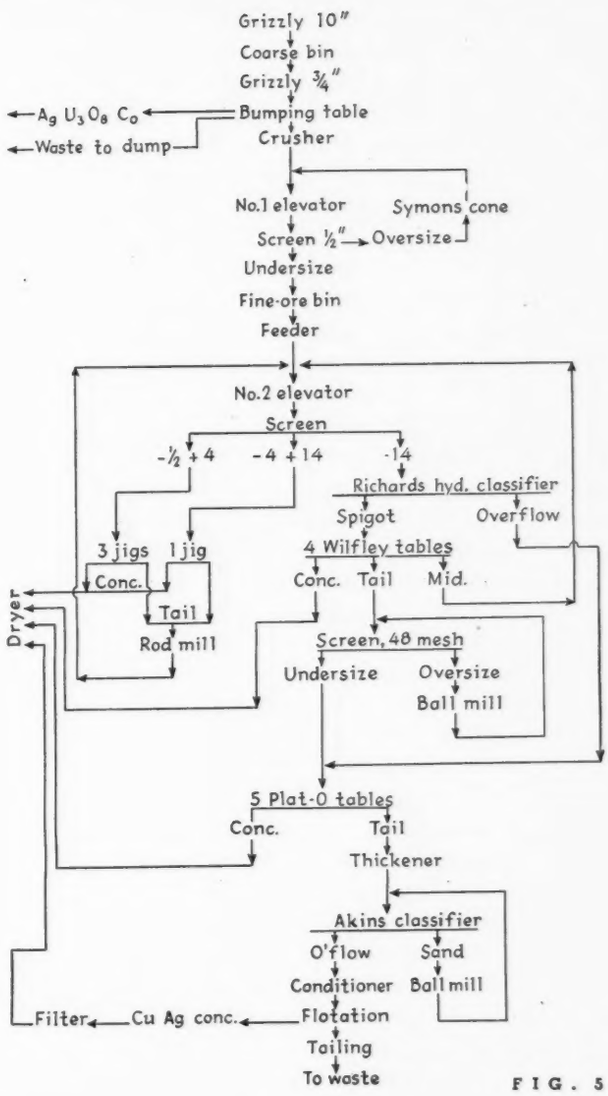


FIG. 5

which high-grade silver, pitchblende, and cobalt-nickel minerals were removed for shipment and waste material was sent to the dump. The remainder of the ore entered a 9x15-in. Blake crusher, where it was reduced to ¾ in. The crusher product joined the grizzly undersize on the belt conveyor and traveled to the bucket elevator, which discharged into a 75-ton fine-ore bin.

Fine ore was fed through a 12-in. H-type wall feeder to a 2x4-ft. Allis-Chalmers vibrating screen with ½-in. openings. Oversize was carried to the rod mill, which carried 12,000 lb. of 4-in. high-carbon steel rods. Rod consumption was 1.75 lb. per ton. Undersize went to a bucket elevator, where it was joined by the rod-mill discharge.

The elevator discharged over a 14-mesh Allis-Chalmers vibrating screen, the oversize from which was treated in an 18x24-in. James jig equipped with slotted perforated plate having 0.063-in. openings. There two concentrate products were formed—a coarse concentrate and a hutch concentrate. The coarse concentrate was drawn through the gate, and it was found that, provided a bed of concentrate was maintained on the screen, the hutch product was equal to or higher in grade than the coarse material. Jig tailing was returned to the rod mill by means of an Esperanza drag classifier.

The minus 14-mesh material was distributed over three No. 6 Wilfley tables, from which a high-grade concentrate was drawn, a large middling product was returned, and a tailing was sent to a 30-in. Akins classifier operating in closed circuit with the ball mill. Ball load was maintained at 6,000 lb. by the addition of 77 lb. of 2-in. drop-forged balls per 24 hours. Ball consumption is 1.3 lb. per ton.

Classifier overflow was fed into a No. 15 Denver Sub-A two-cell flotation unit, from which a copper-silver concentrate was removed. The tailing was distributed over five Plat-O tables, where it was divided into a concentrate, dried for shipment, and a tailing, which was pumped by a No. 2 Wilfley sand pump to the conditioning tank. From the conditioning tank it entered a No. 15 Denver Sub-A four-cell unit, where a copper-silver concentrate was made. The tailing went to the pond.

Reagent consumption in pounds per ton is Aerofloat No. 25, 0.1142; Aerofloat No. 208, 0.0309; sodium hydroxide, 0.144.

Results obtained from the jig operation were so successful that in November, 1937, the flowsheet was altered as shown in Fig. 4.

The crushing unit has remained as before, with the incoming ore being crushed to the same size, ¾ in. Fine ore from the bin is screened on ½-in. mesh, the oversize alone being ground before treatment. The minus 4-mesh plus 14-mesh material is treated in separate jigs. A concentrate is removed from each jig and the tailing is combined and returned to the rod mill. The minus 14-mesh material is treated as formerly.

Observations

Most of our recent work has been with the coarse end of the flowsheet, and the accumulated data tend to show that the hope for higher recovery lies at this point. The results obtained with the various flowsheets are shown in Table I.

Beginning at the fine end of the

present flowsheet, and working forward, we are able to observe the following:

1. In the present flotation of silver the maximum recovery obtained has been 50 per cent of the flotation head. Screen sizing of the classifier overflow shows that not more than 35 per cent will pass 200 mesh, so that finer grinding is probably necessary if higher recovery is to be obtained.

2. At present no more than 25 per cent recovery can be made of U_3O_8 in the Plat-O head. Pitchblende, being an extremely friable mineral, is slimed before it reaches the Plat-O tables and in this form very little concentration takes place. We have shown that up to 87 per cent of the U_3O_8 in the Plat-O head is finer than 200 mesh, and at no point other than the extreme concentrate end of the table is there concentration. We have not returned a middling product, since no middling as such exists.

3. The recovery of pitchblende on the Wilfley tables is practically constant at all sizes other than the very finest. As high as 16.6 per cent of the total head is lost on the Wilfley tables as slime, and it is extremely doubtful if any of this is recovered on the Plat-O tables.

4. Table II shows the operation of the two jigs. The recovery at these sizes is extremely encouraging, but the 64 per cent of the tonnage treated by the jigs contains only 31 per cent of the total U_3O_8 in the mill feed. Since we know that only 6.5 per cent of the original feed was sufficiently fine to pass the 14-mesh screen, 65 per cent of the original U_3O_8 was plus ½ in. in diameter or inclosed in particles of this size.

All particles greater than ½ in. in diameter are sent to the rod mill, and in grinding the very hard jasper the pitchblende is slimed.

Variations in the ratio of concentration, grade of head, and tonnage handled have had no material effect on the over-all recovery. The ratio of concentration is by no means constant, but variations other than normal appear to affect the grade of the concentrate only. The grade of head has had little effect and the tonnage handled does not alter the recovery provided we remain within the capacity of our equipment.

In drawing conclusions from our observations we are led to believe that for a maximum recovery of pitchblende the ore must be reduced gradually by the carrying of high circulating loads, and the valuable material must be removed from the grinding circuit and treated as soon as possible.

In direct opposition to the necessity of treating pitchblende in the coarser sizes we are confronted with a silver content, of which a large percentage is finer than 200 mesh. As our flowsheet stands at present the Wilfley table tailing is ground to give a maximum recovery of both the pitchblende and silver. We know that for a higher silver recovery finer grinding is essential, but this would slime the pitchblende to such an extent that the Plat-O recovery would become negligible.

Combining all facts and assumptions which have some basis in fact, we have drawn up what we consider to be the most desirable flowsheet (Fig. 5) for this type of ore and we are now working towards this goal.

The ore from the coarse bin passes over a stationary ¾-in. grizzly through a water spray to the bumping table, where high-grade material is sorted and waste is removed to the dump. From the bumping table it passes through the Blake crusher and joins the grizzly undersize on the belt conveyor, which transfers it to the bucket elevator. The elevator discharges onto a ½-in. mesh vibrating screen operating in closed circuit with a Symons cone crusher set to produce a maximum of coarse material. Undersize goes to the 75-ton fine-ore bin.

The fine ore feeds by means of a 12-in. H-type wall feeder to the conveyor belt, which discharges into the bucket elevator. The latter discharges onto a vibrating screen equipped with 4-mesh and 14-mesh screens. Plus 4-mesh material is distributed to two James jigs having 3/32-in. screen openings. The minus 4 plus 14 material is distributed to two more James jigs having 0.063-in. screen openings. From these a concentrate is drawn and the tailing is combined to enter the rod mill, the discharge of which joins the original feed in the bucket elevator and is passed to the screen.

The minus 14-mesh material from the screen enters a single-spigot Richard's hydraulic classifier, where the slime is removed and treated on a Plat-O table. Spigot discharge is distributed over four No. 6 Wilfley tables.

Wilfley table tailings are pumped over a vibrating screen with 48-mesh openings and the oversize is returned to the ball mill. The undersize enters a four-spigot hydraulic classifier the products of which are treated on Plat-O tables.

The Plat-O tailing goes to a thickener, from which it is pumped to the Akins classifier operating in closed circuit with the ball mill. Classifier overflow enters a conditioning tank and then a No. 15 Sub-A eight-cell flotation unit. A concentrate is drawn from the first four cells, a middling from the remainder returns to the first cell, and the tailing is sent to the tailing pond.

By this means the pitchblende is treated with as little grinding as possible and the final pitchblende tailing is ground sufficiently fine for the recovery of silver.

Results of concentration for the month of January, 1938, are given in accompanying tables. The mill treated 2,123 tons of ore in addition to 2.6 tons cobbed from the sorting table. Average grade of mill head was 25.99 oz. silver per ton and 1.064 per cent U_3O_8. Recoveries are shown in Table III and the concentrates produced in Table IV. Milling costs are given in Table V.

Table I—Recovery by Flowsheets

Flowsheet	Per Cent U_3O_8
No. 1	58.73
No. 2	62.634
No. 3	64.803
No. 4	73.617

Table II—Jig Operation

	Head	Recovery	
	% Total U_3O_8	% U_3O_8 in Head	% Total U_3O_8
−4+14 mesh	15.598	71.200	11.106
−½+ 4 mesh	15.142	59.459	9.001
Totals	30.740	65.41	20.107

Table III—Recovery of Total Head, Per Cent

	Silver	U_3O_8
Wilfley	31.418	52.876
Plat-O	6.428	4.358
Jig	2.239	16.383
Flotation [a]	14.464	.....
Totals	54.549	73.617

[a] Flotation—Part time operation. Present recovery 30.00%.

Table V—Milling Costs Per Ton Milled

Labor	$0.818
Supplies	0.634
Power	1.383
Cookery	0.406
Distributed	0.735
	$3.976
Sorting	$0.300
Crushing	0.438
Grinding	1.378
Jigging	0.164
Tabling	0.269
Conveying	0.493
Flotation	0.493
Drying and sacking	0.441
	$3.976

Table IV—Concentrates Produced January, 1938

		Grade		Content	
	Pounds	Silver Oz. per Ton	U_3O_8 per Cent	Silver Oz.	U_3O_8 Lb.
Wilfley	90,340	383.89	26.45	17,340.48	23,897.33
Plato-O	11,905	596.05	16.54	3,548.01	1,969.71
#1 Jig [a]	11,313	108.78	39.03	615.33	4,415.80
#2 Jig [b]	10,712	115.93	27.90	620.93	2,988.51
Cobbed U_3O_8 [c]	4,512	.....	25.00 [d]	.....	1,128.00
Cobalt	700	.....	.....	.....	.....
Flotation	23,829	669.99	.....	7,982.68	.....
Total	153,311	.....	.....	30,107.43	34,399.35

[a] Minus 4 plus 14 mesh.
[b] Minus ½-in. plus 4 mesh.
[c] Silver not assayed.
[d] Estimated.

Mining a Deep Lead By the Australian Method

How to effect safe entry into deep-seated gravels overlain with beds of quicksand heavily charged with water

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626 West Pender St.
Vancouver, B. C.

THE RECENT SAFE ENTRY into an ancient channel, or deep lead, in a well-known British Columbia mine, by the application of the Australian system of deep-lead mining, has focused the attention of mining men on that system. The deep lead referred to was loaded with high-pressure water, and contained beds of "slum" or quicksand—a combination of circumstances which, in spite of herculean efforts and the expenditure of large amounts of time and money, had previously prevented a successful entry into the "gutter" for mining purposes.

The fact that the Australian method succeeded where all others had failed is significant, and may be of great importance in developing other known deep-lead systems on the American continent. There seems to be a lack of intimate knowledge of this method in this country, and therefore a brief account of its main features may prove useful to engineers confronting similar difficulties.

Deep Leads in Australia—In Australia the term "deep lead" (pronounced "leed") is used to denote an ancient river bed which, during the course of geological ages, has been filled with gravels and other detritus derived from the degradation of the surrounding hills which contain either auriferous quartz veins, or auriferous gravels or both. In Australia it has been found convenient to classify deep leads as follows: (1) Alluvium-covered deep leads. (2) Sub-basaltic deep leads. (3) Elevated sub-basaltic deep leads.

In the first case, the leads are filled, from bedrock to surface, with alluvial material, the pay streaks being usually confined to the lower 3 ft. of wash resting on bedrock.

In the second type, the sub-basaltic deep leads are those in which the bedrock gravels are covered with an effusive mass of basalt spewed out from once active Pliocene volcanoes.

The last class is merely a variation of the second, and is probably due to slow regional elevation. In this classification of deep leads the protective sheet of basalt has kept them from erosion, and they are often found high up on a mountainside. They are particularly interesting because they can be mined cheaply by using adits instead of shafts.

Most of the work in this branch of mining has been done in Australia; and the most important contribution ever made on the subject of deep leads is a memoir, "The Deep Leads of Victoria," by Stanley Hunter, who was a colleague of mine in the Department of Mines of Victoria, Australia. It was published by that department in 1909, having taken three years to prepare. Unfortunately it is now out of print, but the following excerpts should be of interest.

In the matter of legal definition, Hunter quotes the Mining Development Act of Victoria, Australia, (Clause 2):

" 'Deep Lead' means any watercourse or 'gutter' below the surface of the earth containing alluvial deposits, at depth of not less than one hundred feet from such surface."

Then, in considering the origin and structure of deep leads, he says:

"The rocks and earthy material deposited in these 'deep leads' is the result of the denudation of the surrounding hills which contained auriferous quartz lodes and of surface deposits of auriferous gravels, probably of littoral origin. In a number of instances the heads of auriferous gullies contain quartz reefs which in the past have been, abnormally rich and many are still yielding payable results. Auriferous quartz is, on the whole, more friable and more easily disintegrated by the extremes of temperature, moisture, etc., than barren or buck quartz; consequently while non-auriferous lodes stand pinnacle-like above the surface of the ground, the gold-bearing reefs are usually discovered at or slightly below the surface."

In further discussing the formation of deep leads he says, very graphically:

"The same laws that now control the formation of modern river beds are responsible for the origin of the deep leads. The same denuding agencies, the same steady earth movements slowly uplifting or lowering the surface, the same catastrophic convulsions suddenly altering the contour of the land, have all played their parts from the remote past down to the present hour in the making, destroying, and re-making of our deep leads. The vastly greater number of these are unaltered from the time they were cradled and covered in the ancient valleys, but there are some, classed as 'elevated deep leads,' which are in the old age of their geological life, and only the isolated patches of auriferous gravels covered by a protecting armour of hard basalt represent the once swift rivers flowing onward to 'the ultimate slime of the world.' These rivers would rise in flood time to a formidable width and strength, and would be able to transport untold millions of tons of disintegrated rock oceanwards from the highlands. This denuded material consisted during the early life of the river largely of quartz broken down from the gold-bearing reefs. The gold-studded quartz fragments were rolled along in the flood waters, and worn, broken and shattered, by attrition and the concussion of boulder with boulder, and the gold was freed in 'nuggets,' 'slugs,' and 'flour gold.' After some time, the supply of auriferous quartz becoming limited, other fragmentary material from the granites, slates, and sandstones took its place, and covered up the auriferous gravel deposits with silt, drift, or clay. It must not be supposed that the whole of the gravel or 'wash' deposit in a deep lead is payably auriferous; those portions immediately downstream from a known auriferous quartz zone are nearly always so, but as the lead trends away from such a zone it becomes poorer until another auriferous quartz zone is crossed from which it gathered fresh supplies of gold-bearing gravels. This crossing and recrossing alternate areas of rich and poor country has many times caused the unexpected to happen in alluvial mining, a poor mine following a highly payable one and vice versa."

The deep leads of Australia, particularly the alluvium-covered ones, are

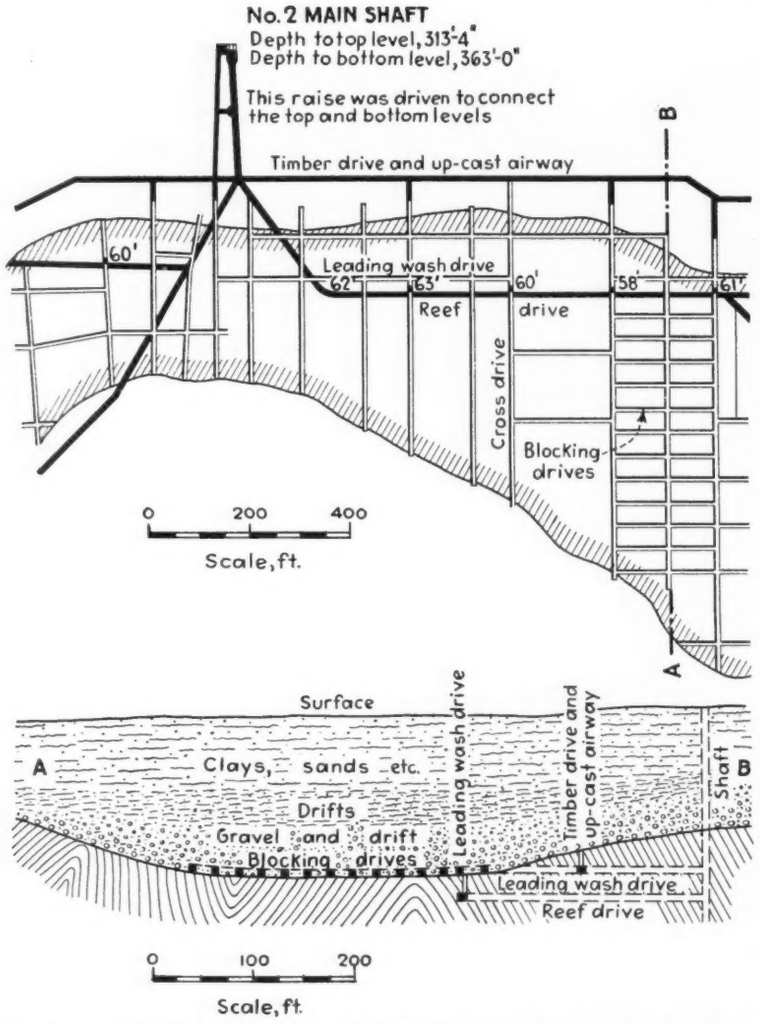

Fig. 1 . . . ALLUVIAL WORKINGS underground on the Chiltern Valley lead, Australia. From the rail level in the reef drive to the wash is 62 ft. The hatching indicates the blocked-out area. The bottom sketch shows a section of the workings along the line *AB*, on a scale twice as big

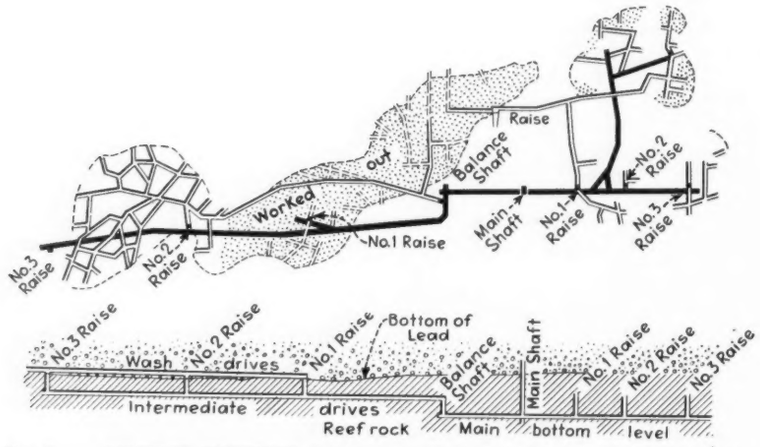

Fig. 2 . . . ALLUVIAL WORKINGS underground, in plan and section, in the Ballarat district, Australia

usually loaded with water (meteoric), which has to be pumped out before active gravel mining takes place.

According to Government statistics, about 10 per cent of the total rainfall in a deep-lead watershed goes down the rivers, 80 per cent would be evaporated, leaving about 10 per cent to seep into the deep lead. If one considers an annual rainfall of only 30 in., it takes only a simple calculation to enable one to realize the quantity of water that can accumulate in the ages that may have elapsed since the ancient valley began to be silted up; although, as a matter of fact, saturation point is comparatively soon reached. Nevertheless, in extreme cases, it has taken upwards of five years of pumping (pumping from two to five million gallons per day), to dewater a deep lead. It is these heavy volumes of water that complicate deep lead mining, more especially if (as is usually the case) beds of slum or quicksand are present. Loaded with water pressure, these slum beds are a menace, especially in shaft sinking, and are the main cause of the many abortive attempts to open up deep-lead mines on this continent. Dehydrated, the slum becomes inert, allowing for safe and easy mining.

Deep-Lead Mining in Australia—The mining of deep-lead deposits, under Australian conditions, formed a part of a paper that I read at the 1934 meeting of the Canadian Institute of Mining and Metallurgy. In that paper I went into some detail about the various methods adopted, and I therefore propose, within the limits of this short article, to deal only briefly with them.

Generally speaking, two systems are employed, known respectively as the Ballarat paneling method, and the Chiltern blocking-out system. Under either system, the main shaft is sunk *in the rim rock,* the steeper side being usually selected. Thus, by sinking the shaft away from the lead, and drifting (still in reef rock) at the correct calculated depth under the lead, all the risks attendant on sinking right over the lead and through the water-loaded strata disappear.

As a preliminary to sinking the main shaft, the position of the deep lead is located by surface drilling right across the lead. Cross-sections, taken at 2,000- to 3,000-ft. intervals, are usually sufficient to delineate the course of the ancient river. This preliminary drilling is an important section of the development on any deep-lead mine if costly errors in shaft locations are to be avoided. One main shaft will control about three miles of the lead, and it is usually placed centrally in that length, allowing one and a half miles of workings downstream, and the same distance upstream. From this shaft, a main drive is started in rock about 50 ft. below the bottom or bedrock of the lead, and continued up and down stream. The downstream rock drive is carried forward on a rising gradient of at least one-half of 1 per cent, to allow for drainage water running back to the sump at the bottom of the main shaft.

When it is understood that the lead will probably fall at the rate of 30 ft. to the mile, the importance of conserving the grade running downstream will be realized. It is advisable, on reaching the downstream limits of a main operation, to have still at least 25 ft. of hardrock cover over the main reef

drive. Hence the need for utmost care in determining the depth at which the main shaft must be sunk.

At intervals of about 50 ft. in both the upstream and downstream drives, drill holes are put up into the gravels, for the dual purpose of draining the lead and of determining its sinuosities between the surface lines of drill holes.

When the hydrostatic pressure in the lead has thus been lowered to a safe point, raises are put up from the reef drive into the gravels, usually at invals of 300 ft. A certain further period of time is allowed for thoroughly draining the gravels, which are then cut up into blocks, and mined either by the Ballarat (paneling) or the Chiltern (blocking-out) system.

Deep Leads in Canada—British Columbia, which is the only part of Canada in which I have so far had experience, is very fortunate in possessing areas which are probably gridded by deep-lead systems, only the shallow and more easily worked parts of which have so far been mined. Several attempts, involving large expenditure of capital and many years of time, have been made to exploit some of the deeper leads of British Columbia, but up to 1937 without success.

So far as I have been able to ascertain, the principal deep-lead systems of British Columbia come under the heading of alluvium-covered deep leads, the auriferous gravels being covered with glacial muck, boulder clay, slum beds, and non-auriferous gravels. The hydrostatic level in British Columbian deep leads is usually found about 20 ft. below the surface, the remaining distance right down to bedrock being filled with water.

In the safe mining of these gravels by "inside mining" methods, it is first necessary to remove this vast accumulation of water (mostly meteoric) by pumping or other methods. An adequate amount of money should therefore be provided for this preliminary work, particularly in opening up a *new* lead. Once the initial entry is made, subsequent major operations on the same lead require much less initial capital, being already partly dewatered.

Typical examples of partly worked deep leads in British Columbia are Williams Creek (the richest creek per mile of bedrock mined); Lightning Creek (ranking next to Williams Creek in richness); Antler Creek; and several others in the Manson Creek area.

The deep leads in the Cariboo district, especially Lightning Creek, are presumed to be rich; but they contain beds of the notorious Cariboo slum which, over a period of about fifty years up to 1937, have defeated every effort to get into the ancient gutter.

Application of Australian System to Canadian Conditions—About the middle of 1934, I was commissioned to

(*Continued on page* 54)

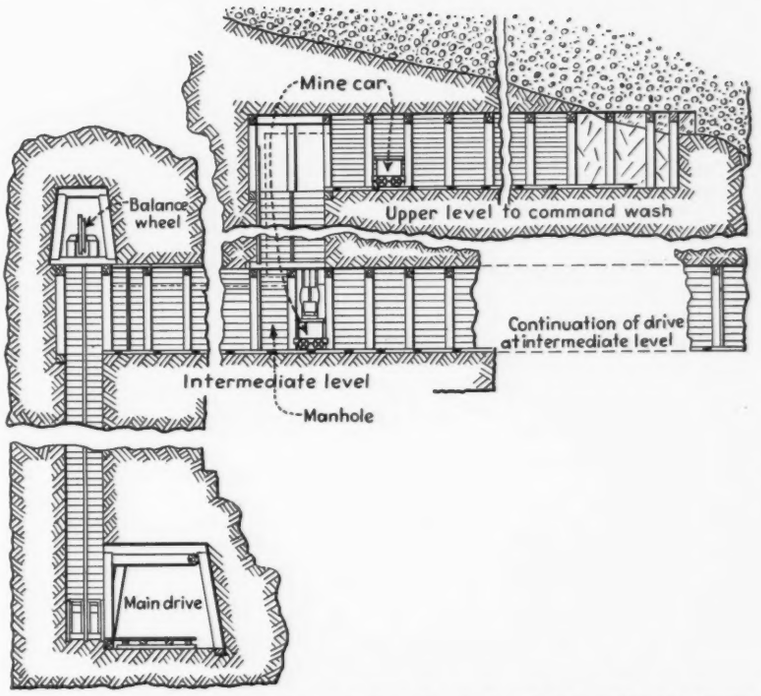

Fig. 3 . . . DEVELOPMENT of the wash from the shaft reef drive under the Australian method is shown in this section. Note the three-compartment raise (end view), the intermediate level, and the upper wash drive. The height of the reef drive to the bottom of the cap is 9 ft., that of the intermediate drive 7½ ft., and of the upper level drive, 6½ ft. Acknowledgment is made to C. B. O'Malley

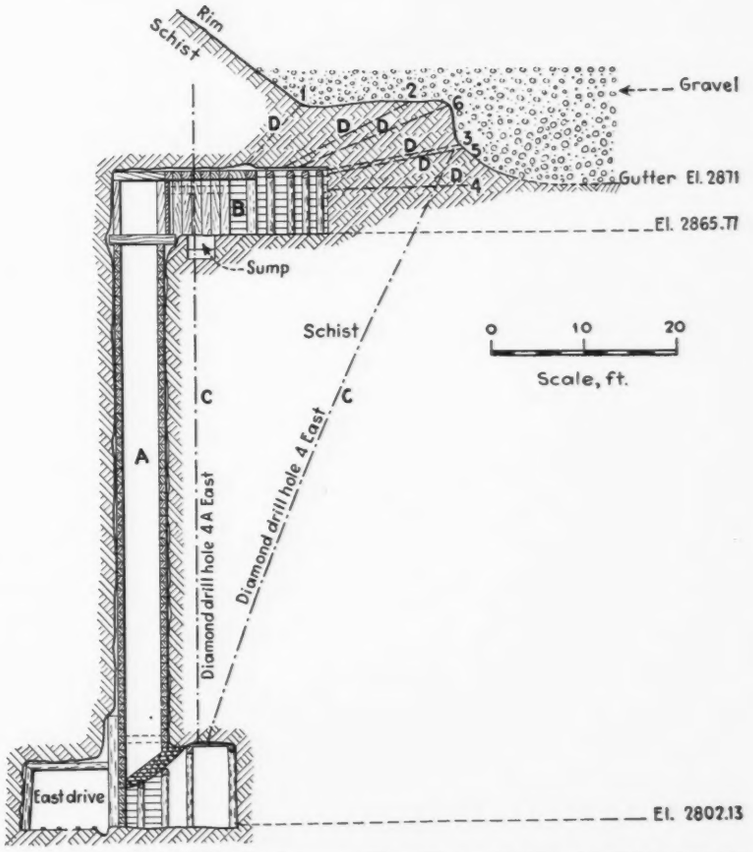

Fig. 4 . . . NO. 1 RAISE (in diagrammatic section) east from the point where the first safe entry was made into the ancient gutter of Lightning Creek, Feb. 8, 1937. *A*, Vertical two-compartment raise fully cribbed. *B*, Crosscust from top of raise into gutter. *C*, Some of the preliminary drainage holes put up by diamond drill into the gutter. *D*. Drainage holes drilled from the crosscut into the gutter before attempting an entry

Some Hypothermal Gold Deposits

Near Bishop, Calif.

A recently developed lode of this type is described by the author

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MY PURPOSE in this paper is to describe a recently developed gold-bearing lode of the hypothermal type in California, and, if possible, to assign the occurrence to its proper niche in the genetic classification of hypothermal gold deposits. Since the early work of Spurr covering the Silver Peak, Nevada, district, no commercial deposits of this genetic type have been described for the Great Basin or Sierran provinces.

Hypothermal types of metalliferous deposits in North America and the Andean province, such as the Homestake and some of the Canadian Shield operations, have in recent years become of increasing importance because of the long and successful production records of certain mines having these types of ores, and because of the significant genesis involved. Isolated veins in many hypothermal gold deposits are likely to be limited in depth and along the strike, but considering groups of such veins as component parts of major lodes, the extended distribution of mineralization along structural zones determined by folding or similar phenomena may give rise to orebodies of remarkable continuity and persistence, laterally and in depth.

The Bishop lode is on the east flank of the Sierra Nevada Mountains in Inyo County, Calif., about 18 miles southwest of Bishop, and the elevation of the outcrop varies from 8,000 to 12,000 ft. (Fig. 1). Prevailing strikes are northwesterly.

At present, the Bishop Creek mine of the Cardinal Gold Mining Company is the only operation in the lode. This property, discovered by A. A. Hassan in the first decade of the century, is near the center of the lode at an approximate elevation of 8,500 ft. above sea level.

In the years immediately following the discovery, the property was operated by various companies, with indifferent success because of the difficulty in treating the complex sulphide ores by amalgamation or cyanidation. The property was purchased from the Anglo-American Mining Company in 1933 by the Cardinal Gold Mining Company, and soon thereafter Cardinal holdings were increased by the addition of the Extension ground adjoining the original purchase on the easterly end, so that the Cardinal company now owns or controls some 13,000 ft. along the lode.

The first flotation plant of modern design, of 150 tons' rated daily capacity, was completed late in 1933 but was destroyed by fire before being placed in operation. Immediately thereafter a new mill with rated capacity of 155 tons per day was built, and this plant continued in operation until the capacity was increased to 300 tons per day in 1936.

During 1936, 56,022 tons of ore was mined containing an average of 0.302 oz. of gold per ton. In all, 1,753.5 tons of concentrates was produced having an average value of 8.60 oz., more or less, of gold per ton. The gross recovered value per ton of ore mined was $9.55.[6]

Physiography—The Sierra Nevada range at these altitude is characteristically rugged and deeply scarred by relatively recent alpine glaciation, so that most of the ridges are serrate with well-developed cirques and aretes. Bishop Creek Canyon, with its neighboring gorges, presents a characteristic U-shaped profile, with sheer polished walls rising majestically to hanging valleys and tributaries. Glacial erratics and tumbled moraine bear further testimony of recent glaciation.

The channels of both the Middle Fork and South Fork glaciers, and at least two tributary ice tongues, cut directly across the outcrop of the Bishop lode, partly dissecting the ore zones. Such recent glaciation, together with the high relief, has practically eliminated the possibility of supergene ore occurrences.

General Geology—Differentiation of the various members of the stratigraphic column exposed in the Bishop lode is difficult because of the masking effects of regional, contact, and hydrothermal metamorphism. All of these factors have combined to alter the original sediments profoundly.

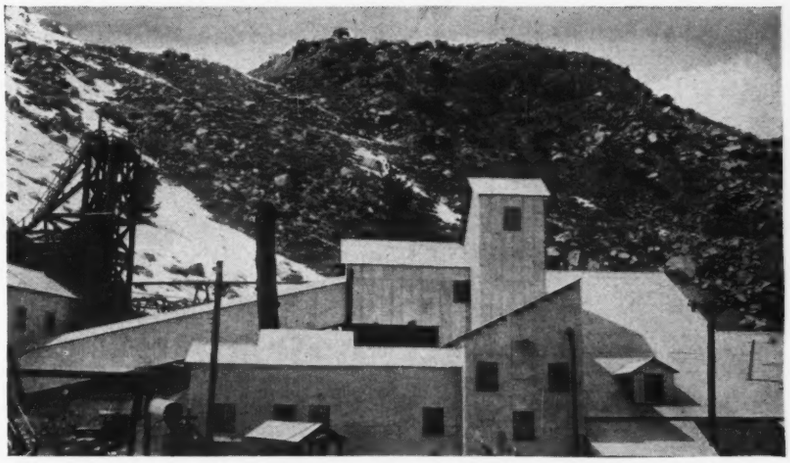
The age of the sedimentary rocks is tentatively fixed as Triassic, because of the similar lithology between these rocks and those of supposed Triassic age in the Inyo Mountains.

Briefly summarized, the sequence consists of a series of warm, shallow-water marine sediments, mostly consisting of clean, well-washed, arkosic sands, rich in quartz; sandy shales, and thin-bedded dolomitic limestones. They were originally deposited in a shallow part of the Pacific Triassic (?) sea over a large part of what is now the eastern Sierra, Owens Valley, and the Inyo range.

As a consequence of the Nevadan disturbance, probably during late Jurassic time, the sediments were subjected to profound and varied stresses, which metamorphosed the original bedded formations into quartzites, schists, gneisses, and allied rocks. At this time, and continuing into the lower Cretaceous, the sequence was buckled and uplifted into the early Sierra Nevada range. The mountain making was accompanied by widespread injection into the sediments of deep-seated plutonic rocks of intermediate (granodioritic) composition.

In the Bishop Creek area, the Nevadan batholith stopped and assimilated its way upward to its present point of emplacement; stoping apparently occurred on a grand scale, since large foreign inclusions and roof pendants are common. In a few localities huge blocks of the sediments were completely engulfed and now occur as isolated outliers of the Bishop lode.

During the plutonic invasion, contact metamorphism caused still further alteration of the sediments. Practi-



THE OUTCROP of the Bishop Creek granite is seen in the right background. Late moraine overlying the ore horizon appears in the left background. This is on property of the Cardinal Gold Mining Company

IN THE 200 STOPE of the Bishop Creek mine. This view affords a good idea of stope widths in the Perry ore block

SAMPLING CREW at work, in the 400 Perry stope of the Bishop Creek mine of the Cardinal Gold Mining Company, Inyo County, Calif.

FLOW CLEAVAGE banding in the Perry ore zone with minor fracture cleavage on the extreme left is seen here, in the 400 Perry stope of the Bishop Creek mine

or early Cretaceous (?)—Even granular to porphyritic quartz monzonite. Locally as acidic as granite or as basic as diorite. Most of the femic minerals, as well as the minor syngenetic pyrite, have been weathered in the outcrops to iron oxides; hence reddish colors are common. Locally altered, when an ore wall rock, to a coarsely crystalline glistening "greisen" by hydrothermal metamorphism. This member occurs not only as a wall rock for the pendant, but as crosscutting sills, fingers, and apopheses which have in some cases localized oreshoots by damming action.

Satellitic Igneous Rocks as complementary and pegmatitic dikes, sills, and irregular bodies probably should be classified with the Bishop Creek granite as end-phase products of the magmatic invasion. Some of these rocks are intrusive along passive fractures or zones of weakness, and are persistent enough to serve as mappable markers. Most of them are irregular, erratic, and unpredictable masses that vary in composition from aplites to minettes, with occasional local pegmatites.

cally all of the limy members were altered to wollastonite and grossularite with minor amounts of tremolite. The contact mineralization was accompanied by deposition of quartz and pyrite.

Stratigraphy

The stratigraphy of the region in the vicinity of the Bishop lode is shown briefly in the following descriptions of the rock occurrences of the area:

Talus (0 to 50 ft.)—Angular to subangular fragments of slide material, rock glaciers, and the products of recent erosion ranging in size from gravels to boulders of granitic and metamorphic rocks. Includes stream gravels of the recent cycle.

Late Moraine: Late Pleistocene (0 to 1,000 ft.)—Poorly consolidated and unclassified masses of glacial débris. Material from both lateral and medial moraines. Fragments from sands to gigantic boulders and erratics. Particles angular to subangular, frequently striated. Occurs both in canyons, and high up on side hills, where it frequently masks the bedrock.

Bishop Creek Granite: Late Jurassic

Sebrina Complex: (50 to 1,500 ft.) Triassic (?)—Intercalated arkosic sandstones, fine sandy shales, and thin-bedded dolomotic limestones metamorphosed into quartzites, schists, gneisses, and hornfels. In the gneissic and schistose facies, the sediments are dominantly "stretched" quartzites which may be lightly albitized and biotized in the vicinity of oreshoots. The general strike of the Sebrina in the vicinity of the Bishop Creek mine is about N. 60 deg. W., with a dip of about 70 deg. north in the upper workings of the mine. There may be local reversals in dip as depth is attained.

The Sebrina is still further subdivided into the *Banded Quartzite* (0 to 50 ft.), which is a brown, gray or white stretched quartzite with a well-developed flow cleavage, and contains occasional feldspars, and has a sugary texture in the vicinity of ore; *the ore horizon* (generally

Fig. 1 . . . THE BISHOP LODE is on the east flank of the Sierra Nevada Mountains, in Inyo County, California, approximately 18 miles southwest of Bishop

speaking, the more highly contorted facies are the most favorable zones for ore); and the *Sanford Quartzite*, which is a pure white to cream-colored, translucent, sugary-grained quartzite, locally grading into hornfels. Sometimes faintly banded, more often massive. It is barren.

Structure—The Sebrina complex, the ore-bearing horizon of which has here been designated as the Bishop lode, is localized as a roof pendant of irregular dimension within plutonic walls of intermediate to acid composition. Regionally the pendant pinches and swells along the strike. The lower limits have not been reached, but from diamond drilling and mapping it is known to have a vertical range of at least 3,700 ft. Approximately six miles have been studied along the outcrop of the lode.

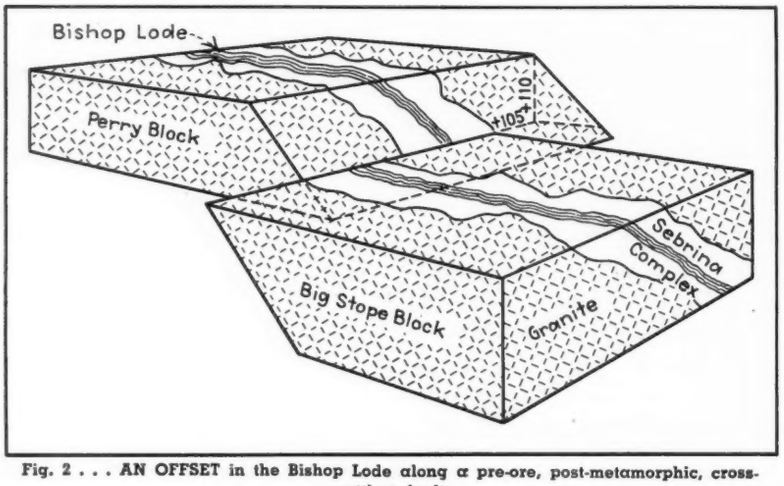


Fig. 2 . . . AN OFFSET in the Bishop Lode along a pre-ore, post-metamorphic, cross-cutting fault

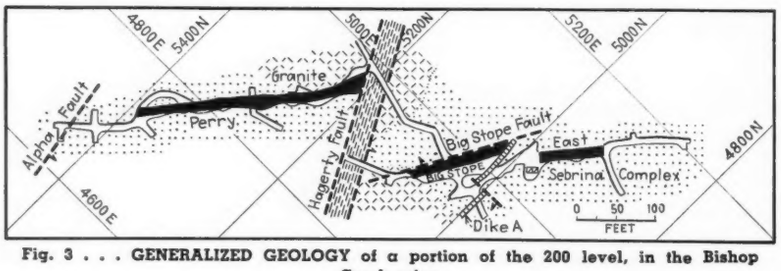


Fig. 3 . . . GENERALIZED GEOLOGY of a portion of the 200 level, in the Bishop Creek mine

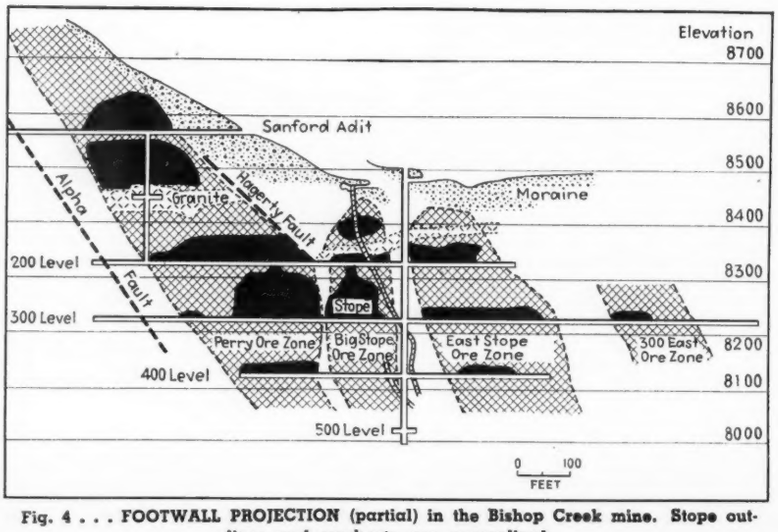


Fig. 4 . . . FOOTWALL PROJECTION (partial) in the Bishop Creek mine. Stope outlines and oreshoots are generalized

The structural features of the Bishop lode may be divided into two categories: (1) structures that are apparently critical as ore localizers, and (2) structures that may not be critical as localizers but may have a definite economic aspect.

1—Critical structures, in the order of their importance, are flow cleavage, pre-ore breaks, intrusive bodies (especially sills), and fracture cleavage.

Flow and fracture cleavage probably antedate the Nevadan intrusion and may be thought of as cartographically important reflections of dynamic metamorphism.

Various members of the Sebrina behaved differently under stress. The sandy shales were compressed and distorted into schistose bands of irregular dimension. The sandstones were compressed, flattened, recrystallized, lost volume, and generally assumed an attitude roughly parallel to the flow cleavage in the shaly facies. Slates are rare, apparently because of the dominantly siliceous composition of the shales, and are nowhere in evidence within the workings of the Bishop Creek mine.

The limy and dolomitic rocks were consolidated, compressed, underwent flowage, and were generally recrystallized into marbles of varying magnesian content. Because of their incompetence these easily replaceable rocks are the most highly contorted, and throughout the lode they occur as lenticular masses with greatest dimension along the strike. The dimensions of such lenses are limited by incasing quartzites.

Individual lenses may vary in length from a few inches to several tens of feet—a factor that limits the diamond drill as an accurate sampling device. Likewise, this peculiarity may in large measure explain the lenticular shape of minor oreshoots. In the Bishop lode, field evidence indicates that metasomatism along flow cleavage planes, especially with the replacement of diopside and quartzite, has been of major importance in ore emplacement.

Fracture cleavage has been of similar but subordinate importance in connecting pyroxenized areas and in rendering the favorable ore horizons more porous.

As a phenomenon of structural control, pre-ore faults are frequently subordinate only to flow cleavage as critical localizers, as may be ascertained by referring to Fig. 3.

Normal faulting, at least in the Bishop Creek mine, seems to be the most important structure of this category. A typical example is illustrated, together with approximate displacements, in Fig. 2. Certain critical faults of this type are apparently zones of weakness that have been more or less

active since pre-ore times. Where the largest of these breaks intersects the granite rocks, it is marked by gougy fault zones up to 30 ft. in width, but where the less competent sediments are intersected, it fingers out into numerous, anastamosing, knife-edge fissures.

Prior investigators apparently had the idea that movement along such faults was entirely post-ore, presumably because of offsets in the lode, and their observations are not without support in the field evidence. However, recent work has shown that gold values frequently show a marked increase immediately beneath the footwall of such faults, the large gouge zones influence the shape and rake of oreshoots, fault gouge shows weak sulphide mineralization, and the occasional quartzite breccia with the zone of attrition is barren. Furthermore, in the vicinity of incompetent sediments, where such major breaks are marked by anastamosing fingers, rather than gouge zones, the mineralization may be too diluted to form ore; that is, widths are greater, but values smaller, in such blocks.

This evidence suggests to me that ore solutions arising along the planes of flow cleavage and minor fracturing were impounded by the pre-ore gouge of crosscutting faults, and the oreshoots were accordingly given rakes roughly paralleling the fault zones. If this be true, one would expect to find richer ore immediately adjacent to such zones of attrition, and apparently this is indeed a characteristic of many of the orebodies of the Bishop lode.

In pre-ore times, the prevailing pressures probably mitigated against such faults presenting the more or less open channels of circulation now visible. More probably there were occasional zones of weakness and sheeted zones which partly restricted circulation.

Exploration for oreshoots along several breaks, based on the pre-ore-movement concept, within the Bishop lode, has demonstrated that the theory is not without merit.

It must not be inferred from this evidence that post-ore movement along crosscutting faults has not occurred. Rather, the evidence indicates that movement has been continuous and perhaps gradually increasing since pre-ore time. Too many live rifts and major faults exist in this region of active mountain-making to overlook the possible connection of large breaks in the Bishop lode with the still larger orogenic faults of the region.

Evidence concerning the critical role of crosscutting intrusive and pegmatitic masses as localizers by the impermeable barrier effect, indicates that these igneous bodies may have played an important role in localization, somewhat comparable to the role played by the pre-ore gouge zones mentioned in the foregoing.

Sills of the pre-ore age, cutting across the lode, appear to have localized ore by damming in at least two instances, and in another instance the upper end of a large orebody appears to terminate some distance below a crosscutting sill, but against relatively insoluble and impermeable contact aureole.

In summation it may be said that the critical pre-ore structures of the Bishop lode are flow and fracture cleavage, pre-ore breaks, and intrusive contacts and related contact zones.

2.—Non-critical structures, such as joining, sheeting, and similar phenomena, do not have any economic significance other than a bearing on the usual mining problems.

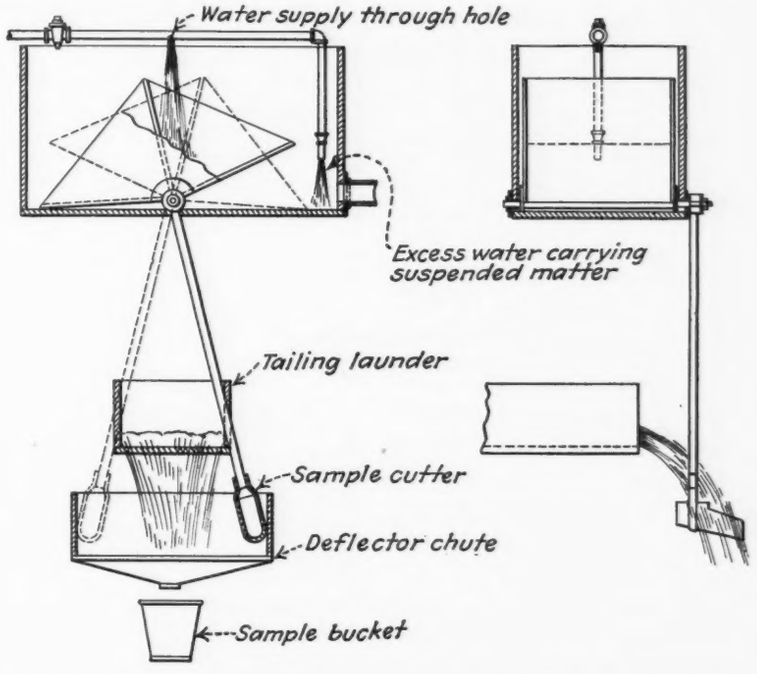
Unconformity between the base of the late moraines and the Bishop lode is of marked economic importance, because such structures are frequently watercourses in the district, and hence limit upward stoping because of the danger of flooding.

(To be concluded)

▼ ▼ ▼

A Water-operated Pulp Sampler

THE ACCURACY of a water-actuated pulp sampler depends on the uniformity of the time interval between cuts. If the pulp fluctuates little in value, and a small sample is needed from the large stream, precise adjustment of water delivered to the weighting compartments must be made. To maintain a very small flow by valve adjustment is sometimes difficult. Suspended matter in the water causes chokage of the valve and interruption to the operation of the sampler.



At a South American cyanide plant it was explained that the sampler would function without attention only if the water valve was opened wide, to obviate stoppage. The sampling mechanism was in view, but the bucket was hidden. Investigation disclosed the fact that the bucket was filled long before it was removed at the end of each shift by a native workman. Between samplings, the solids settled in the bucket, so that at each subsequent operation of the sampler, an equivalent bulk of clear liquid overflowed the bucket. As this liquid contained gold and silver, although in small amounts, the ultimate sample was obviously incorrect, and the assay an underestimation of loss.

The condition was remedied by redesigning the sampler so that all parts, including the bucket, were in plain view, and by transferring responsibility to the shift boss. To obviate chokage of the water pipe, a small hole was drilled in it, as shown in the accompanying sketch. The pipe carried a full bore of water at all times, being slightly reduced toward the extremity, which discharged the excess into the box taking the water from the compartments of the sampler. This change was found to insure a small and uniform flow of water to the sampler, even when the water supply was badly contaminated with wood, which occurred periodically during the rainy season.

Michigan's Potential Iron Ores

And the Outlook for Their Beneficiation

With particular reference to flotation

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THE HISTORY of mining ventures has been, first, utilization of rich ores with comparatively little or no beneficiation, and then, increasing beneficiation of the ores as they became leaner. In the same way, the potential iron ores of Michigan probably will also require beneficiation to prepare them for the present smelting or any other reduction process. Hitherto, with ores of favorable texture, it has generally been cheaper to eliminate the bulk of the gangue by dressing rather than by chemical means. The choice of a dressing process for a particular ore is guided by the texture of the ore and by the properties of the minerals to be separated. Nearly all of Michigan's potential ores are fine-texture,[1] and they will require fine grinding to free the valuable iron minerals from the gangue.[2] In the non-ferrous and nonmetallic fields, the problems of fine-textured ores have been solved by the application of froth flotation. Concerning this process and the properties of the potential iron-ore minerals to be separated, flotation separation is based upon difference in chemical and physico-chemical properties. Because these properties are different in every mineral, it is theoretically possible to separate any combination of minerals. From all of these facts flotation appears to be a likely process for the technical beneficiation of the potential ores.

The applicability of flotation to the present problem is discussed under the following headings: (a) low-grade siliceous formations, (b) high-sulphur and high-phosphorus ores, (c) rejects from gravity concentration, (d) cost of flotation, and (e) the flotation concentrate in succeeding processes.

Low-Grade Siliceous Formations—The mining of at least two tons of low-grade formations is necessary to produce one ton of concentrate. Thus, beneficiation of this ore from underground mining appears economically impossible, whereas treatment of similar ore from open-pit mining is more promising because open-pit costs are much less than underground costs.

About one-half of the members (banded) of the Ironwood formation on the Gogebic Range are amenable to gravity concentration.[3] These members are separated by others which are finely textured and not amenable to the same type of concentration. Further, because of their relative position and dip, the coarse-textured members if considered alone would have to be mined by underground methods; whereas, if beneficiation were developed for the finer-textured members, the whole formation could be mined to considerable depth by open-pit methods.[4] Thus, there is great need for a process, such as flotation, which is applicable to the fine-textured members.

High-Sulphur and High-Phosphorus Ores—The Menominee Range contains much fine-textured, high-grade ore (in so far as iron content is concerned) which, however, is not salable because of a deleterious sulphur or phosphorus content. Large blocks of ore have been developed during search for material with low sulphur or low phosphorus contents. These ores would yield a relatively large quantity of finished concentrate as compared to feed, because their deleterious mineral content is generally less than 5 per cent. Considered from this viewpoint, the beneficiation of these ores is more attractive economically than is that of other potential ores.

Rejects From Gravity Processes—As stated in the foregoing, some of the banded members of the low-grade siliceous formations are amenable to gravity concentration. Treatment of these ores by gravity concentration would yield fine and middling products (locked hematite and porous hematite),[5] all of which would be refractory to the parent process. Flotation, perhaps, can be applied to these rejects, first because it is adapted to the treatment of fine material and second because flotation separation is based on differences not in specific gravities but rather in chemical and physico-chemical properties. This reject material, salvaged by flotation, would yield a relatively low-cost concentrate; there would be no charges, or only small ones, for mining and comminution on current rejects, and an only slightly greater expense on piled material. Flotation of this type of material appears to be the most logical starting point for the application of the process.

Cost of Flotation—Recent developments in the flotation of phosphate rock furnish commercial examples which are quite similar to the present problem in regard to the physical condition of the ore, comparative quantities of valuable and worthless minerals, and required purity and value of the finished concentrate product. The direct operating costs for the flotation of tailing from a Florida phosphate rock washing plant were $0.148 per long ton of feed.[6] (The flowsheet with which these costs were obtained included grinding for flotation.) Whether these costs can be duplicated or, possibly, even reduced remains to be determined. The important fact is that flotation costs have been reduced to the extent that the process is not an utter impossibility in iron-ore beneficiation.

After Flotation What?

The Flotation Concentrate in Succeeding Processes—One of the chief objections to the flotation of the potential ores has been that the process produces fine concentrates which need to be sintered before being smelted in the iron blast furnace and that the cost of such sintering makes flotation unfeasible. In considering these objections several facts are pertinent. As shown in the foregoing, the greater part of the potential ores will require fine grinding for dressing, regardless of what process is used thereafter to bring about the separation of the valuable from the worthless minerals; consequently, flotation must be considered on an equal basis with any other process in so far as this phase of the problem is concerned. The objection to flotation—the cost of concentrate sintering—is based on the assumption

that the present practice in iron-ore smelting will not be changed. If this be the case, the effect of natural iron ore and of sintered fine ore or concentrate in iron blast furnace economics must be carefully considered.

Marked improvements in blast furnace economics have been reported when sinter was partly substituted for natural Lake ores.[7] Possibly such desirability of sinter will eventually result in a higher price being paid for it than for natural ore. This condition would automatically pay for a part, at least, of the expense of sintering. Quantitative data on the subject are lacking and only careful investigation will indicate how completely the greater value of the sinter will pay for its preparation.

But assuming, on the other hand, that the blast furnace will be found wanting and will be replaced, then several known possibilities must be considered. These can be summed up under (a) replacement of the blast furnace by a somewhat similar reduction smelting equipment, (b) direct methods, and (c) leaching and electrolytic reduction.

Reverberatory a Possibility

Iron ore has been smelted in a reverberatory furnace, and several hundred tons of iron have been produced with "surprisingly encouraging results."[8] Adoption of this method of smelting would entirely remove the objection to the fineness of flotation concentrates, because the concentrate would be fully as desirable as coarser material in the reverberatory furnace.

The direct methods or processes proceed to the stage of making wrought iron or steel without reduction smelting. Reduction is carried out, with carbonaceous materials at lower temperatures than prevail in blast furnace smelting; consequently the charge is not similarly liquefied, and separation of the reduced iron from the gangue is not possible to the same extent as in the process at the higher temperature. As a result, in direct processes either (a) very high-grade ore or concentrate must be used, or (b) the iron must be concentrated after the relatively low temperature reduction.

It is of special importance to this phase of the problem that high-grade concentrates from other ores are being produced by flotation and that finely ground materal such as flotation concentrates can be treated in all of the direct processes. It is also of interest that sponge iron from direct methods is being used in steel making and that reduced metallic oxides are one of the principal forms of raw material for powder metallurgy, a recent and important innovation in the fabrication of metals.

Flotation, leaching and electrolytic precipitation have been combined satisfactorily in the winning of nonferrous metals, and the same results can probably be obtained if economic production of electrolytic iron becomes possible. Of interest in this connection are the facts that the use of very pure metals is increasing rapidly, that electrolytic metals are being used in powder metallurgy, and that small quantities of extremely pure electrolytic iron have been produced commercially.[9]

Because, as shown in the foregoing, flotation is a likely beneficiation process for the potential ores, considerable work has been done on the first stage (laboratory research) of the problem. This research[10] can be conveniently discussed under theoretical research and practical research. The theoretical research consists of a study of the flotative properties of each of the minerals and of synthetic mixtures of these minerals that are important in the problem. Thereafter the theoretical data were applied to typical samples of the potential ores—this last work being the practical research on the problem.

Theoretical Research—The principal minerals in the potential ores are hematite, magnetite, limonite, gypsum, pyrite, barite, quartz, feldspar, mica and other silicates, kaolin, apatite, and other unknown minerals of phosphorus. (Although the study of chert, siliceous minerals, and slimes does not properly fall under this heading, the procedure and purposes are the same as with the pure minerals; therefore the study is included at this point.) Naturally occurring minerals—as pure as it was possible to obtain and purify them—were used, and the properties of each were studied under carefully controlled conditions.

Hematite and magnetite are the main iron minerals in the potential ores, and gypsum is the principal carrier of sulphur in the high-sulphur ores. The results from a study of these minerals have been previously published; therefore only reference to these publications need be made at this time.[11]

Some Research Applicable

Research which is concerned directly with this problem has not been done on the gangue minerals quartz, feldspar, and mica, or on pyrite, another source of sulphur in some of the harder potential ores. However, the following work that was done on carefully purified minerals is entirely applicable to the present problem. Gaudin and Glover,[12] Iverson,[13] Fahrenwald and Newton[14] all studied the flotative properties of quartz; Iverson[13] also did similar research on feldspar and mica, and Lange[15] investigated pyrite in the same way.

Similar data are not available on the flotative reactions of limonite, iron silicates, kaolin, apatite, and other minerals of phosphorus. All of this information is necessary and remains to be obtained before satisfactory information on this phase of the problem is realized. Finally, chert and intimate mixtures of varying proportions of hematite and siliceous minerals must also be studied. This last work is necessary because many of the ores are so finely textured that it is impossible to free the valuable mineral by usual grinding. Thus, this particular problem is not one of separating iron minerals from gangue minerals, but involves the separation of grains containing much hematite from those containing little of this mineral.

Effect of Slimes

The most important part of the theoretical work is study of the effect of slimes. Separation of the coarse grains of the various minerals is comparatively simple, but it is difficult or impossible to separate the extremely fine ones. To obtain information on this subject, the effect of slimes (from pure minerals and potential ores) on pure coarse minerals is being studied under controlled conditions.

A thorough study of this problem requires much work; scarcely a beginning has been made at this time. From 0 to 2.0 grams of —8+4-micron slimes from (a) pure massive hematite, (b) 50 per cent iron ore, (c) 27 per cent iron ore, and (d) pure quartz were added to the flotation of —65+200-mesh pure massive hematite. To make the data from the four slimes comparable, equal amounts of slime surface area were added to the individual tests. Sodium oleate was used both as a frother and collector in this work. Pure quartz slimes had little effect on the flotation of the coarse hematite, whereas the other slimes produced activation with very small and marked depression with larger quantities. The slimes fall in the following order of decreasing depressive action: pure quartz, 27 per cent iron ore, pure massive hematite, and 50 per cent iron ore.

As already stated, the separation of synthetic mineral mixtures is another phase of the theoretical research. Although the following work on quartz-hematite mixtures was not directly concerned with the present problem, the results nevertheless are applicable. Gaudin and Glover floated hematite and depressed quartz with sodium oleate and terpineol.[16] Dean and Herbsberger effected a nearly quantitative separation of hematite from quartz with an emulsifier and a mineral oil.[17]

A nearly perfect separation of gypsum from hematite was made by flotation of the gypsum and depression of the hematite with sodium oleyl sulphate. A fair separation was ob-

tained with sodium oleate and sodium silicate if froth was collected only during the first two minutes after the addition of sodium oleate—gypsum floated as soon as the collector was added, whereas hematite required more time for conditioning. Finally a good separation was made with sodium oleate and an activator for gypsum, cellulose nitrate (collodion).

Practical Research

The practical research consisted of laboratory tests on samples of typical potential ores. A high-sulphur ore that contained 0.81 per cent sulphur (mainly as gypsum) was ground to pass 65 mesh and then it was given a single flotation treatment with sodium oleyl sulphate. The tailing from this treatment contained 0.08 per cent sulphur and 90 per cent of the iron content of the feed.

Another high-sulphur ore containing 1.9 per cent sulphur was tested to eliminate pyrite, the source of sulphur. Flotation with amyl xanthate and pine oil recovered 95 per cent of the iron content of the feed in a product (tailing) which had 0.23 per cent sulphur. When the same ore was treated with ethyl xanthate and sodium oleate, a tailing with 0.15 per cent sulphur was produced, and 90 per cent of iron was recovered in it. Also, the iron content of the tailing was 5 per cent greater than that of the feed.

Microchemical examination of a high-phosphorus ore ground to pass 80 mesh showed that 20 per cent of the hematite grains contained relatively large quantities of phosphorus and that the remainder of the grains contained little or nothing of this element. Rougher flotation of this ore (0.32 per cent phosphorus) with ammonium palmolate[18] gave the following results: 35 per cent of the weight of the feed and the iron content were in the concentrate, and the remainder was in the tailing. The concentrate and the tailing contained respectively 0.55 per cent and 0.18 per cent phosphorus.

One of the banded low-grade formations amenable to gravity concentration was tested to determine whether flotation salvage of gravity middling and fines was possible. The material was ground to pass 65 mesh, and then it was classified at 600 mesh with a laboratory bowl classifier—the sands and slimes being respectively 75 and 25 per cent of the feed. Results showed that the slimes contained 23 per cent iron; their flotation with sodium oleate was unsuccessful. The sands (26 per cent iron) were floated with sodium oleate, fuel oil, and soda ash to produce a cleaner concentrate, a middling, and scavenger tailing. The grades of these products were respectively 54, 24 to 36, and 1.8 per cent iron. Concentrate and middling had 97 per cent of the iron content of the +600-mesh sands. Assuming that the silmes must be entirely discarded, then the sands concentrate and middling contained 75 and the reject material (scavenger tailing and silmes) 25 per cent of the iron in the original feed.

Although the results from preliminary tests herein detailed are not satisfactory, they nevertheless are encouraging and show that separation is possible. Further research undoubtedly will improve on these results and provide adequate flotation processes for the various types of potential ores.

FOOTNOTE REFERENCES

[1] Certain banded formations have a coarse pseudotexture. However, the bands actually are mixtures of fine-textured hematite and siliceous minerals and they range in composition from nearly pure hematite to nearly pure siliceous minerals.

[2] T. M. Broderick: "Applications of Geology to Problems of Iron Ore Concentration." *A. I. M. E.*, Contrib. No. 20, 12, 1933.

[3] F. J. Tolonen: "Gravity Tests on Michigan Iron Formations." Contrib. 46, 17, 1933, *A. I. M. E.*

[4] Ref. No. 2, page 13 of the article cited.

[5] Hematite has been rendered porous by leaching and removal of silica so that the apparent density of the iron mineral approaches that of silica; thus separation from silica by differences in specific gravities becomes, correspondingly, more difficult.

[6] H. S. Martin: "Milling Methods and Costs at the No. 2 Concentrator of the Phosphate Recovery Corporation," Milling Methods 480, 1934, *A. I. M. E.*

[7] R. McClurken: "Sinter in Blast Furnace Burdens. Blast Furnace Steel Plant." 20, 342, 1932.

[8] E. W. Davis: "Iron Ore Beneficiation in the Lake Superior Region." Milling Methods 831, 1934, *A. I. M. E.*

[9] J. J. Lloyd: "Alkaline Electrolytic Iron." *Canadian Mining Journal*, 50, 1137. 1929.

[10] Unless otherwise credited, the research discussed in succeeding paragraphs has been done at the Michigan College of Mining and Technology.

[11] W. E. Keck, et al: "A Study of the Flotative Properties of Hematite, of Magnetite, of Gypsum." Pub. 763, 801, 762; 1937, *A. I. M. E.*

[12] A. M. Gaudin and Harvey Glover: "Flotation of Some Oxide and Silicate Minerals." Utah Engineering Experiment Station Tech. Paper No. 1, 78, Univ. of Utah, 1928.

[13] H. G. Iverson: "Selective Flotation of Feldspar and Mica From Quartz." Master's thesis, Univ. of Utah, 1930.

[14] A. W. Fahrenwald and Joseph Newton: "Measuring Settling Rates of Mineral Suspensions." *E. & M. J.*, 138, 23, 1937.

[15] L. H. Lange: "Flotation of Pyrite and Pyrrhotite." Master's thesis, Univ. of Utah, 1930.

[16] A. M. Gaudin and Harvey Glover: "Flotation of Some Oxide and Silicate Minerals." Utah Engineering Experiment Station Tech. Paper No. 1, 97, Univ. of Utah, 1928.

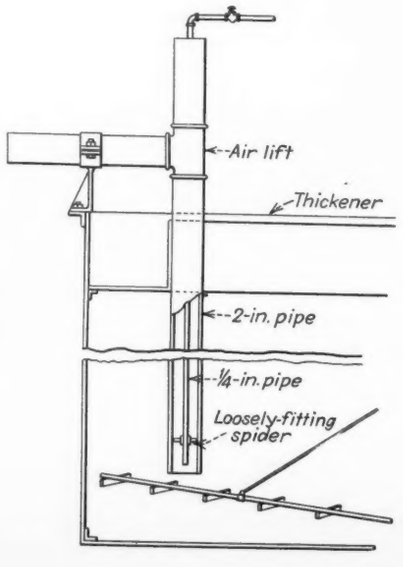
[17] R. S. Dean and A. B. Herbsberger: "New Flotation Reagents." Tech. paper No. 605, 1935, *A. I. M. E.*

[18] An ammonium soap of palm oil.

▼ ▼ ▼

Small Air Lift Prevents Overloading Of Thickener

OCCASIONALLY the Dorr thickeners in a countercurrent decantation plant become overloaded with amorphous slime. Attempt to remedy this by increasing the underflow adversely affects metallurgical results, because of the increase in ratio of solution to ore in the direction of discharge. The problem was solved in a South American cyanide plant, pending radical flowsheet changes, by continuously drawing, by means of a small air lift, a slime pulp from the settled zone in the outer part of the first displacement thickener, and thus taking advantage of the classifying action within the unit.



The air lift, which was hung over the side of the thickener, as shown in the accompanying sketch, extended down to within a few inches above the rakes. It was made entirely from scrap material, 2-in. pipe being used for the lift section and ¾-in. pipe for the air pipe. The latter, extending downward to within a few inches above the bottom of the lift pipe, is held in a central position by means of a loose-fitting "spider." Because of the excess of submergence as compared with lift, only a negligible amount of air was needed, and duplicate valves on the air line were necessary. In the original application of the scheme the slime pulp so removed was sent direct to filtration. If much slime pulp has to be removed, two or more air lifts, separated by several feet, are preferable to one large one.

Crushing Costs Reduced At Dos Estrellas

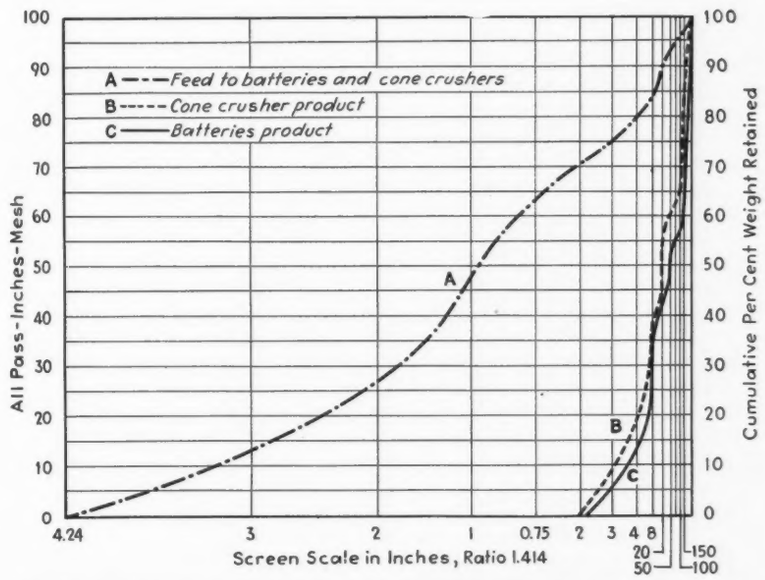
New plant betters those obtained with stamps by 5.67 cents

W. B. Rhodes
Superintendent of Mill and Shops
Cia. Min. Las Dos Estrellas
Dos Estrellas, Mich., Mexico

THE AVERAGE COST of crushing with stamps at the plant of Cia. Min. Las Dos Estrellas, operating at Dos Estrellas, Michoacan, Mexico, having risen from 15 centavos, national currency, per ton in 1932 to 25 centavos in 1933, the company replaced 40 stamps in 1934 with a 4-ft. Symons standard fine bowl crusher. This, in combination with the remaining stamps, brought the cost down to 16 centavos. In consequence a new crushing plant, replacing the old, was installed in 1934, consisting of a 5½-ft. Symons standard fine bowl cone crusher and a 7-ft. Symons Short Head crusher, with accessory equipment. The two crushers are driven by Westinghouse 3,000-volt synchronous motors of 200- and 300-hp. respectively. All units are remote-controlled from a central station in the plant and are so interlocked that if any unit stops, all units in front of it stop immediately, while those following it continue running.

In the new plant, which began crushing Nov. 1, 1935, the mine ore is dumped over rails set 10 in. in the clear into the mill bin. From this it passes by conveyors to grizzlies having 2-in. spacing. Oversize goes to gyratories set to 4 in., their product joining the undersize and going by conveyor to the 5½-ft. cone crusher, set to 1 in. Tramp iron is removed from the crusher feed by a stationary magnet over the belt and a magnetic head pulley.

EL CEDRO MILL, at Dos Estrellas, Michoacan, looking north. The new crushing plant, installed Nov. 1, 1935, is dealt with in the text



THE SCREEN ANALYSES, shown below, were made on samples of (A) feed to batteries and cone crushers, (B) cone crusher product, and (C) batteries product. On the graph above they have been plotted cumulatively

Screen Opening	A. Per Cent	A. % Cumulative	B. Per Cent	B. % Cumulative	C. Per Cent	C. % Cumulative
+4.24″	0.0	0.0	0.0	0.0	0.0	0.0
+3.0″	13.0	13.0	0.0	0.0	0.0	0.0
+2.0″	13.0	26.0	0.0	0.0	0.0	0.0
+1.0″	20.0	46.0	0.0	0.0	0.0	0.0
+¾″	17.2	63.2	0.0	0.0	0.0	0.0
+2	6.8	70.0	0.4	0.4	0.0	0.0
+3	5.4	75.4	8.0	8.4	5.7	5.7
+4	4.4	79.8	10.0	10.4	6.2	11.9
+8	4.0	83.8	14.4	32.8	15.5	27.4
+20	8.0	91.8	20.2	53.0	15.0	42.4
+50	2.6	94.4	6.6	59.6	6.3	48.7
+100	0.4	94.8	4.6	64.2	6.1	54.8
+150	1.0	95.8	1.0	65.2	1.1	55.9
—150	4.2	100.0	34.8	100.0	44.1	100.0

The 1-in. crushed product drops onto a 30-in. conveyor set at 20 deg., which delivers it to a 6x12-ft. Gyrex vibrating screen set at 25 deg. and having $\frac{5}{16}$x4-in. "no-blind" openings. This type of screen is necessitated by the character of the ore, consisting mostly of old fills. Screen undersize is conveyed on 24-in. belts to the tube-mill surge bin. The oversize goes to the 7-ft. Short Head crusher, set to $\frac{3}{16}$ in., the crushed product going to another 6x12-ft. vibrating screen, also set at 25 deg. and having $\frac{3}{16}$x4-in. "no-blind" openings. Oversize from this screen joins the product of the 5½-ft. crusher, thus being in closed circuit with the 7½-ft. crusher. The undersize goes by conveyor to the tube-mill surge bin.

The crushing plant runs 22 hours out of 24 hours on all days except Sunday, when it is down. All inspection and cleaning is done in the two-hour interval. Liners are changed on Sunday. Liners for the larger crusher last three to three and one-half months; those for the 5½-ft. unit approximately 8 months. The screens last three to four weeks.

(*Continued on page 53*)

The Sullivan Mine Today

At Kimberley, B. C., the Consolidated's great property is producing at the rate of 7,500 tons per day

John B. Huttl
Assistant Editor

WAYS OF MEASURING the status of a mining enterprise in any country are numerous. Among the indexes are (a) operating earnings; (b) value and quantity of metals produced; (c) new capital spent in developing and equipping mining properties—either new or old; (d) discovery of new ore deposits and the degree of activity in general exploration and prospecting; and (e) dividends. A company of which it can be said that all these points have been met successfully year after year is the Consolidated Mining & Smelting Company of Canada, Ltd., premier mining undertaking in British Columbia.

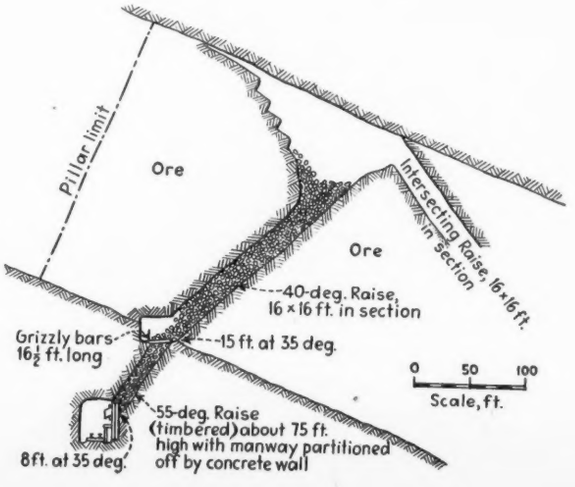
Incorporated in 1906, the company represents one of the few large projects on the American Continent with a record covering more than 31 years of steady expansion of commercial and engineering achievement. Production amounted in 1937 to 206,579 tons (short) of lead; 142,650 tons of zinc; 2,292 tons of copper; 218 tons of cadmium; 9,846,545 oz. of silver; 52,435 oz. of gold; and, in addition, 13,533 tons of sulphur; 57,832 tons of ammonium sulphate; 44,221 tons of other chemical fertilizers; and 132,194 tons of sulphuric acid (expressed as 100 per cent acid). Apart from the three principal mining and smelting operations—namely, the reduction plant at Trail, B. C., and the great Sullivan mine and concentrator at Kimberley, B. C., some 200 miles away—the company controls the West Kootenay Power & Light Company and several mining properties in different parts of Canada, including the Big Missouri, in the Portland Canal district, now being prepared for production. The effective coordination of these component parts has been the result of balanced growth, under the direction of Selwyn G. Blaylock, vice-president and general manager, assisted by an enthusiastic and able staff.

In the matter of employer-employee relationship the company has always maintained a policy of close cooperation with its workers in periods of high as well as low metal prices for lead and zinc. Wages are increased whenever possible, money is being advanced to men on favorable terms to build homes, excellent hospitals are available at Trail and Kimberley, group insurance and pensions are free of charge to workers, and profit-sharing and bonus systems are in force during periods of high metal prices. Since the introduction of cooperative committees by Mr. Blaylock, the different units have been entirely free from strikes. All these factors and numerous other concessions have contributed to enhance the trust and confidence in the company on the part of the workers, with resultant increased efficiency throughout the many departments of the organization. As a result, the several communities have enjoyed conditions that would be welcomed in many a mining district elsewhere, and the company has been able to carry every one of its 5,000 permanent employees throughout the recent depression.

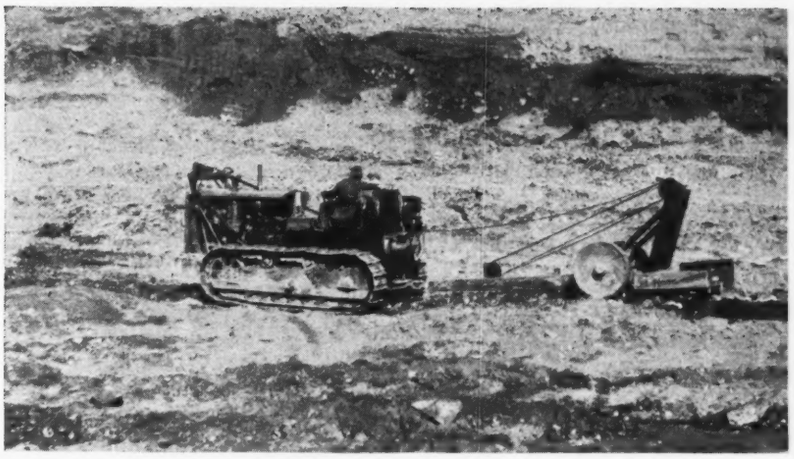
During a sojourn in British Columbia a short time ago I had an opportunity to visit the company's operations at Trail and Kimberley. These were described in 1931 in a series of excellent articles by G. J. Young (*E.&M.J.*, Vol. 131, Nos. 5, 7, 9, 11, and Vol. 132, No. 3). However, as mining, milling, and smelting methods never long remain stationary, an account describing some of the new developments since that time may be of interest.

The Sullivan mine today is producing at the rate of more than 7,500 tons per day, six days a week. During 1936 about 1,910,619 tons of ore were mined, and development work completed during that period included 3,085 ft. of drifting, 1,474 ft. of crosscutting, 4,415 ft. of raising, 319 ft. of sinking, and 9,007 ft. of diamond drilling. Though underground mining methods have remained substantially the same as already described in the articles cited, many improvements have been made recently in the direction of dust control and in the back-filling of mined-out areas, preparatory to mining pillars. Adoption of newer drilling, transportation, and hoisting equipment, and careful coordination of the diverse undergound operations, have increased efficiency and lowered costs. Mining of remnant pillars by means of hollow or filled reinforced-concrete pillars has been abandoned. In its stead, the general plan for waste-rock filling, to be described later, was adopted after considerable study and experimentation.

The history of the Sullivan mine dates back to 1892, when Pat Sullivan found the outcrop of the vein almost opposite the North Star outcrop. In 1896 the mine was bonded by A. Hanson, of Leadville, and later by Colonel Redpath, Judge Turner, and their associates, who formed the Sullivan Group Mining Company. Development began in 1900, and during the next few years lead-ore shipments were made. In 1903 a smelter was constructed at Marysville, but operating difficulties caused a shutdown in 1907. Reorganization fol-


Pillar limit
Ore
Ore
Intersecting Raise, 16×16 ft. in section
40-deg. Raise, 16 × 16 ft. in section
Grizzly bars-16½ ft. long
15 ft. at 35 deg.
0 50 100
Scale, ft.
55-deg. Raise (timbered) about 75 ft. high with manway partitioned off by concrete wall
8 ft. at 35 deg.

STOPING is a combination of underground glory-hole and room-and-pillar methods. Mining is usually begun where two transfer raises driven from opposite directions meet at the hanging wall



BACK FILLING in the Sullivan mine is done with semi-cemented gravel, available in large quantities on the surface. The upper 10 ft. of this is removed by bulldozers, and subsequent layers are handled by a combination of rooting and scraping. The three photographs above show (1) a tree-tooth rooter loosening gravel; (2) a 12-cu.yd. carryall moving gravel; and (3) two bulldozers pushing gravel into the shaft or raise

lowed under the name of Fort Steele Mining & Smelting Company, which was controlled by the Federal Mining & Smelting Company. The present owners took a lease and bond on the property late in 1909, which was exercised the following year after a comprehensive diamond-drill campaign.

The Sullivan ores are essentially replacement deposits in the Aldridge argillaceous quartzite of Pre-Cambrian age, occurring conformably with the beds in a general way, but possessing some of the features of a vein. There are two principal ore zones, the north and south, the intervening area, 800 ft. in length, being occupied by a body of pyrite and pyrrhotite. The orebodies are large, massive deposits, ranging up to 265 ft. in thickness in places. Though the footwall of the vein is well defined, the hanging wall, in contrast, is irregular, and upper limits require exploration. The strike is approximately north and south and the dip, which varies from 10 to 35 deg., is to the east. Folds and overturns complicate the structure and more or less influence mining. Because of the intimate association of the sulphides of lead, zinc, and iron—that is, galena, marmatite, pyrite, and pyrrhotite—the typical ore could not be beneficiated profitably until selective flotation had been successfully developed. The aforementioned sulphides also carry values in silver, cadmium, tin, and traces of other metals. Ratio of lead to zinc is about 1.35 to 1, although high-grade lenses of lead and zinc are found separately in both the north and south ore zones.

The main haulage level, known as the 3,900 level, 7,100 ft. long, is at an altitude of 3,864 ft. This is a 10x12-ft. drift extended northerly from the portal above Mark Creek in the quartzites on the footwall to the lode at the north orebody, with a drift extension more than 4,500 ft. in length along this horizon. Reinforced-concrete posts with a cross-section measuring 12x12 in., and steel I-beams protected by acid-resisting paint, are used for its support. Additional working levels include the 4,250, 4,450, 4,500, and 4,600, the latter having an adit from the surface. All levels between the 3,900 and 4,500 are served by a 50-deg. incline shaft containing two skipways and a manway. Connection with the 4,600 level is made via a winze. The 4,250 and 4,450 levels are intermediate levels, and the 4,600 level formerly served as an outlet to what was originally known as the "upper mine." Recently a raise has been equipped as a man and material shaft to facilitate operations in the south districts of the 4,500 level. Considerable development work has also been done below the 3,900 level to test the downward extension of the orebody. This included sinking an incline shaft to the 3,350 level, building ore and waste pockets at this point, driving exploration drifts and crosscuts, and diamond drilling. Results attained so far are said to be more than encouraging.

Mining of ore is accomplished by a combination underground glory hole-room-and-pillar method. The section to be exploited is laid out in alternate pillar and stope areas the dimensions of which are largely determined by the thickness of the orebody. In general, they are 50 ft. wide and 200 ft. long. Development consists of footwall crosscuts and parallel footwall drifts, usually 200 ft. apart. From these, incline raises, at 55 deg. and 7x16 ft. in section, are driven to the footwall. Each raise is timbered and contains a manway and an ore pass. The timbers are removed on completion. Next, a bulldoze chamber, 10 ft. high, 24 ft. long, and 16 ft. wide, is cut out partly in the footwall and partly in the ore, after which the raise is continued for

15 ft. at an angle of 35 deg. and narrowed down before being extended at 40 deg. and later enlarged by slashing to 16x16 ft. through the ore to the hanging wall. The grizzly bars, placed in the bulldozing chamber at an angle of 15 deg., consist of three 100-lb. rails, 16½ ft. long, bound together by angles and bolts, and spaced 24 in. An 18-in. concrete wall between the manway and transfer chute affords access to the chamber. All raises are equipped with standard air-operated chute gates. To permit the use of safety belt ropes, eyebolts are placed at strategic points in the roof of each bulldozing chamber.

Stoping Practice

Stoping operations are carried out in several cycles, with a stope usually being started where two transfer raises (driven through ore and untimbered) from opposite directions meet at the hanging wall. However, before actual mining commences, the position of the hanging wall is first tested by a series of diamond-drill holes drilled with a portable unit mounted either on a bar or tripod at this point. One of the aforementioned raises is used as a manway and the other as an ore transfer. The point of intersection usually coincides with the end of a stoping portion. Here, the hanging-wall section of the vein is mined first until no ore will run to the transfer by gravity. When this point is reached, benches are taken off from the raise, which gradually give the stope a funnel shape as shown in the drawing. Benching operations are continued until the footwall is reached, after which the stope is worked by room-and-pillar methods, with a scraper actuated by a double-drum reversible air hoist transferring broken ore to the transfer raise.

During these operations a close watch is kept on the back of the stope. A crew of barmen make periodical inspections, and take down any bad back that might develop. Tools used by them include hollow Duralumin bars with detachable steel points, special ladders made from straight-grained lumber and painted red, and powerful storage-battery hand lamps and searchlights. All stoping is done on a contract basis, the contractor buying his own explosives and the company supplying the tools and equipment. Usually, two machines are used in mining the hanging-wall section, and one machine is employed in benching operations. These machines are mounted on tripods or bars, with the bench holes being drilled at an upward angle of 35 deg. and 12 ft. deep. About 54 ft. per machine are drilled each shift, and the tonnage per machine is nearly 80 tons. Contract prices vary from 10c. to 40c. per ton. Drills employed are G.-D. D79 drifters using 1-in. octagonal hollow vanadium alloy steel manufactured by the English Steel Corporation. Raise drilling is done with I-R R51 stopers and 1-in. steel, and jackhammers are used for blockholing, which is generally carried out in the bulldozing chambers. Blasting is done with 35 and 60 per cent gelatine dynamite, the consumption per ton being about ⅓ lb.

The various stoping operations are so coordinated that only a minimum number of men is in the stope at all times. Another safety measure is blasting at a set time throughout the mine, which is around 10 p.m. The signal consists of emptying the air lines and filling them again after an interval of 10 min. As the country rock (quartzite) is strong and hard, no timber whatever is required in stope and development openings. Storage of ore in the stopes is kept to a minimum, and for the following reasons: (1) The ore is subject to oxidation and must be sent to the mill soon after it is broken if a satisfactory recovery by flotation is to be effected, and (2) a machine cannot be set up until a certain amount of ore has been drawn from the face. Each round blasted in the stope is sampled and estimated as to grade and tonnage, which makes possible delivery of a fairly uniform grade of ore to the mill.

As mentioned previously, the stopes in general are carried 50 ft. wide and 200 ft. long, with pillar dimensions of the same size. They are so spaced that pillars on the upper 200-ft. strip correspond to the stopes on the next lower strip. With the stoping method employed about 75 per cent of the ore is recovered. Remnant pillars will be mined after the waste-rock fill introduced into the openings in a novel manner has sufficiently hardened. The method of back filling perfected and adopted recently involves driving an incline raise at 70 deg., 7x14 ft. in section, from the highest point of the hanging wall to the surface, and bulkheading all outlets in the stope with reinforced-concrete walls. The upper part of the transfer chute is sunk through about 100 ft. of gravel, connection with the raise being made in solid ground. All concrete walls or dams covering the low parts in the stope are 2 ft. thick, and contain a series of drain pipes. Those on level ground have a manhole covered with two layers of 3-in. planks for observation purposes. The planks are later chopped out when the fill is to be investigated. Timbers in the shaft and raise are blasted out and allowed to drop into the stope before filling work is actually started. The fill material available on the surface is a semi-cemented gravel, averaging 100 ft. in thickness. Following is a typical wet screen sample:

Size	Per Cent
+2 in.	17.3
—2 in. to +½ in.	20.1
—½ in. to +¼ in.	9.9
—¼ in. to 10 mesh	11.5
—10 mesh	16.2
Clay	25.0

The gravel is mined with Caterpillar RD8 diesel tractor with bulldozers, LeTourneau three-tooth rooters, and LeTourneau 12-yd. carryalls. The upper 10 ft. of the gravel is removed by bulldozers, and subsequent layers are handled by a combination of rooting and scraping. Filling into the shaft is done by three bulldozers dumping at set intervals to allow about 15 per cent water to be added to the gravel. Addition of this amount of water was found to create a semi-fluid sludge which will run on a slope of 10 deg., with little loss of surplus water. Production of the three bulldozers is about 800 cu.yd. per 8-hour shift, and they are used where distances from 400 to 500 ft. are involved. For longer hauls, the carryall is used. Work is suspended during the winter months.

All development drifts and raises are driven on contract. Drifts advanced in quartzite and those in ore are respectively 9x9 ft. and 9x10 ft. in section. The complete blasting cycle—that is, setting up two drills on horizontal bars, drilling, loading and blasting, and removal of broken rock—requires about 16 hours, with two men on each shift. An 18-hole V-cut round is used in the 9x9-ft. drifts, and a 24-hole round for the 9x10-ft. openings. This is done with G.-D. D89 and I-R DA35 drifters using 1¼-in. round hollow English Steel Corporation steel. Contract prices vary from $9 to $13 per foot. Broken material in drifts and crosscuts is removed by Armstrong mucking machines. As in drifting operations, the crew in the 40-deg. and 55-deg. raises consists of two men. In the smaller raises (40 deg.) the drilled round is blasted each shift; that in the 55-deg. raises is blasted after two shifts. In this work I-R R51 wet stopers with 1-in. octagonal steel are in use, and contracts are from $7 to $10 per foot and $12 and $16 per foot respectively.

Mechanical Ventilation

Ventilation in the mine is mechanical. Equipment provided includes: at No. 9 shaft a 62,000-cu.ft. Jeffrey reversible fan; a 95,000-cu.ft. two-stage reversible Aerovane fan at No. 11 shaft, which operates primarily as an exhaust fan at 2-in. water gage; two 18,000-cu.ft. single-stage Aerovane fans; two No. 3½ 5,000-cu.ft. Canadian Sirocco fans; and two blowers. The two large units are controlled by push-buttons and lights in the underground hoist room, and exhaust through long raises from the backs of the stopes in the north section of the mine, the intakes being in the south section. Total air exhausted by these fans is about 160,000 cu.ft. of free air per minute. The six smaller fans are chiefly operated as boosters or to divert and control air currents in the mine.

In addition to improved ventilation, use of water sprays and atomizers,

respirators and electric lamps, curtailment of secondary blasting during shift hours, and wet drilling have reduced dust hazards to a minimum. The water sprays on each air-operated chute gate in the mine consist of a 1-in. pipe with staggered $\frac{1}{16}$-in. holes installed under the cap of the chute. With a water pressure of more than 100 lb., there results a very fine spray over the rock running from the chute, which is attended by two men. The atomizers, made with a center jet of air at 90 lb., are principally employed at the grizzlies and at the top of raises when broken rock is being dumped off the level. In the stopes, however, they were found to cause considerable fog and consequent reduced visibility. Ordinary water hose is used in drifts and raises for spraying the face and broken rock.

Secondary blasting in the stopes is confined, as much as possible, to the end of the shift, when for a full hour no operator is in the opening. In the chutes, large rocks are blockholed and blasted instead of bulldozed. In operations where concentration of dust is unavoidable, three types of Willson respirators are used—namely, the No. 22 with replaceable silica filter pads, the fume and smoke mask, and the No. 2 bag respirator. All are supplied to the men free of charge. Use of electic lamps has proved particularly beneficial in confined working places, where prior to their adoption considerable dust was added to the mine air by men dumping spent carbide three or four times during the shift. Sampling of dust is done both by gravimetric and konimetric methods. A Whatman thimble apparatus and a Zeiss konimeter are available for this work.

Ore loaded in 6-ton Granby-type cars on the 3,900 level is hauled in 30-car trains a distance of about 1½ miles to the primary crushing plant near the portal of the tunnel. These cars are rapidly being replaced with 12-ton units equipped with flexible trucks, springs, and roller bearings. Track gage is 36 in., and 70-lb. rails are used in the main haulageways and 45-lb. rails in side drifts and intermediate levels. The trains are drawn by 10- and 12-ton trolley locomotives operated in tandem. Direct current for the 250-volt trolley system is supplied by four motor-generator sets, which receive current from a power cable taken underground through a 3-in. diamond-drill hole. There are two other such cables, and all carry 2,200 volts.

All underground workings are electrically lighted, and telephone service and drinking water are available at central points. Water for drilling and other purposes is obtained from dammed-up dead ends. Since October, 1935, only Model K Edison cap lamps are used by the miners. Well-equipped underground shops assure a constant supply of sharp drill steel and serviced drilling machines. Under the guidance of a safety engineer and first-aid instructor, safety devices have been installed wherever necessary and men instructed, with a consequent substantial decrease in accidents. Complete first-aid equipment is stored at strategic points both underground and on the surface, and heated ambulance cars are stationed in the mine and at the portal of the tunnel.

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Crushing Costs at Dos Estrellas

(*Continued from page* 49)

Crushing began Nov. 1, 1935, and continued without interruption save as noted. In Table I are given cost data for the six months beginning with this date.

Table II gives a summary of the cost of crushing by batteries, as formerly.

An examination of the cumulative plots of screen analyses on the accompanying charts shows that the batteries did 2.6 per cent more work in crushing the ore than is being done by the new plant, so we must deduct from the final figure given in Table III this amount, which favors the batteries. Calculated this gives 5.5216 cents, or 20.8390 centavos. These amounts represent the true difference in the cost of crushing a ton of ore under present conditions in favor of the new crushing plant as compared with the batteries. On the basis of the saving indicated in the foregoing, 1.727 years would be required to liquidate the new plant.

Table I—Crushing Costs, Dos Estrellas Plant, Nov. 1, 1935, to April 30, 1936

Ore crushed, tons	387,852.0
Ore crushed per hour, tons	116.7
Ore crushed per 24 hours, tons	2,800.8
Kilowatt-hours per ton ore crushed, kw-hr.	1.353
Cost per kilowatt-hour per ton of ore crushed, U. S. currency, cents	1.035
Mexican currency, centavos	3.7267
Total cost of liners for 5½-ft. and 7-ft. Symons crushers, Mexican currency	$18,993.69
Liner cost per ton of ore crushed, U. S. currency, cents	1.36
Mexican currency, centavos	4.9
Total oil and grease cost, Mexican currency	$1,282.93
Total screen cost, Mexican currency	3,896.34
Total material cost, Mexican currency	$24,172.96
Materials cost per ton of ore crushed, cents	1.73
centavos	6.23
Total labor cost chargeable to new plant during the November-April interval, Mexican currency	$14,593.98
Labor cost per ton of ore crushed, cents	1.045
centavos	3.765

Total crushing cost per ton of ore chargeable to new plant and surge bins:

	U. S. Currency, Cents	Mexican Currency, Centavos
Power	1.0352	3.7267
Materials	1.7300	6.2300
Labor	1.0450	3.7650
Total	3.8102	13.7217

Table II—Former Cost of Crushing by Batteries

Average kilowatt load per 24 hours on a 2,340 metric ton basis during 1933	225.0
On a 2,800-ton 24-hr. basis, the average kilowatt load would be	269.1
Number of days worked during 1933	352⅔
Number of hours worked during 1933	8,454
Total power consumption, kw-hr.	2,274,971.4
Tons crushed in 1933	623,506
Kilowatt-hours per ton crushed	3.65
Power cost per ton of ore crushed, cents	2.7927
centavos	10.0537
Labor cost for 12 months, Mexican currency	$46,025.23
Cost per ton of ore crushed, cents	2.052
centavos	7.485
Materials cost corresponding, cents	4.2653
centavos	15.2523

Materials and labor costs are calculated on present costs, being approximately one-third higher than in 1933.

Table III—Cost Comparison Between Batteries and New Crushing Plant

	Power		Materials		Labor	
	Cents	Centavos	Cents	Centavos	Cents	Centavos
Batteries	2.7927	10.0537	4.2653	15.2523	2.052	7.485
New plant	1.0352	3.7267	1.7300	6.2300	1.045	3.765
Difference in favor of new plant	1.7575	6.3270	2.5353	9.0223	1.007	3.720

Difference in favor of new plant on 2,800-ton basis:

	U. S. Currency, Cents	Mexican Currency, Centavos
Power	1.7575	6.3270
Materials	2.5353	9.0223
Labor	1.0070	3.7200
Total	5.2998	19.0693

Since the new plant does not work Sundays and the batteries did, a further saving for 52 Sundays must be added to the above difference. This amounts to:

	Cents	Centavos
	0.3750	1.3480
Add above difference	5.2998	19.0693
	5.6748	21.4173

Deep-lead Mining

(Continued from page 41)

come to Canada to introduce the Australian system at the Wingdam mine, Lightning Creek, the property of the Consolidated Gold Alluvials of British Columbia, Ltd. Here there were a number of factors that made the task considerably more difficult than, theoretically, one might have expected. One such factor was the climate, particularly the sub-zero temperatures, which necessitated a great deal of work, of apparatus, of precaution and risk that Australian conditions do not call for.

A second factor was the work previously done at this particular mine, which made it impossible to start absolutely *de novo*, as would naturally have been ideal.

Third, there was the lack of miners trained in this class of mining—hard-rock mining proving of but little use as a training for the inside mining of gravels. As a matter of fact, it was found that men with coal-mining experience had had the best preparation.

Altogether, alowing for six months' loss in development owing to the unfortunate burning down of the power station, it took two years and one month before the gutter was successfully entered, early 1937.

The Melvin Development

During this period, the following development program was carried out in the Melvin mine:

1. 6,734 ft. of Keystone drilling (from surface).
2. Main shaft sunk in rock 276 ft.
3. 1,985 ft. of main rock tunnel driven.
4. 3,208 ft. of underground diamond drilling and reaming.
5. 807,000,000 Imperial gallons of water pumped from the "deep lead"
6. 1,000 hp. power station installed.

These items show the main points of development at the Melvin mine only, and do not include the development of an interglacial moraine at the Sanderson mine.

Following the Australian practice, a shaft was sunk in rim rock (which in this case is a graphitic schist, of moderate hardness, locally known as Cariboo schist) to a distance of about 50 ft. below the deepest point of the lead or gutter. A main reef or rock drive was then driven up and down stream for a total distance of about 2,000 ft., drainage holes being meantime drilled up through the intervening rock into the gravels, so that the process (often long) of dewatering the gravels was being proceeded with from the earliest possible moment.

By the end of January, 1937, the water pressure at the various testing stations in the Melvin shaft mine had fallen to the point where it was considered safe to extend the crosscut at the top of the raise right into the gutter. This was successfully accomplished on Feb. 8, 1937, when at 2.30 a.m. the roof laggings in the 6x4-ft. crosscut were driven through the rim rock into the gutter.

A final check-up on our instruments had indicated that we should expect about 6 ft. of water in the old channel —equal to 2.7 lb. per square inch. Actually, we found a little less than 5 ft., thus proving the reliability of our pressure-testing methods.

Practice at Wingdam

Drainage Holes From Main Reef Drive Driven Into "Gutter"—At Wingdam our practice was to drive short "offsets" at about 75-ft. intervals along the main reef drive, to act as chambers for the drilling operations. At first, percussion machines were tried, using a heavier type of machine than the commercial drifter. Great difficulty was experienced in keeping the rod couplings from breaking, and it was decided to try out a small diamond drill energized by compressed air.

Had the rock between the main reef drive and the gutter been of uniform hardness, no difficulty would have been experienced in putting up these holes. With alternate layers of hard and soft strata, the drilling became more complicated and expensive.

The method we adopted in putting up these holes was as follows: An ordinary air drill (drifter type) was set up in the drilling station on the angle to be drilled. Using a 3-in. full bit, a hole was drilled for about 6 ft. The air drill was then dismantled and a 3-in. pipe inserted into the hole for at least 5 ft. and cemented in that position.

A gate valve was attached to the end of the pipe for control purposes, also a ½-in. pipe was "teed" off the side of the pipe for pressure testing. The diamond drill was then put into position and drilling proceeded through the open gate valve. A 2-in. hole was drilled right into the gravel, which could be later reamed out to 3 in. if deemed necessary.

When the gravels were entered, there was usually a rush of water carrying a little sand; but in a few minutes the water would run clear, and continue so.

Frequently the hole would choke up, and some form of teasing rods would have to be inserted into the hole to clear it out. In Australia we used light iron rods about 2 ft. long, hinged together to form one continuous length of 50 to 60 ft. At Wingdam we used a ¾-in. galvanized pipe, coupled at 10-ft. intervals, which acted very well.

In a hole which is likely to run fine sand, a wise precaution is to use a "tubing rose" for the actual drilling in the gravel. The tubing rose is about 6 ft. long, and is pierced with 40 to 50 ¾-in. holes with additionally several slots cut at irregular intervals. A driving shoe about 7 in. long, with a 1½-in. hole though the middle, is securely fastened to top end of the tubing rose. The drainage hole is continued for 6 ft. into the gravel, and, with the tubing rose in position, usually continues to run clear.

When a presure test is being made, a hydraulic gage (marked in single pounds) is attached to the small ½-in. pipe, fitted just above the gate valve. The gate valve is then closed, and the pressure allowed to build up, which usually occupies only a few minutes. The time, place, and pressure in pounds per square inch are carefully recorded.

In checking a hydraulic gage reading, we replace the gage with a tube leading to a mercury column, and read the pressure in inches of mercury. As hydraulic gages are hard to calibrate, we found the mercury column an admirable check.

I have gone into some detail in connection with the method of putting up the drainage holes and of testing the water pressure, because the whole outcome of the operation depends on the successful carrying out of this part of the work. Each mine is likely to produce local conditions of rock and gravel that will test engineering skill and ingenuity to the utmost, and it is generally at this stage that it happens. One must be prepared to do quite a bit of improvisation and juggling in order to get the drill holes through and running freely and clearly.

Summary

To recapitulate: The chief points of the Australian system, then, are:

1. Preliminary surface drilling.
2. The sinking of the main shaft *in rim rock*, and to a carefully calculated depth below the gutter.
3. The driving of a main reef-tunnel up and down stream from this shaft, and the drilling up of drainage holes, colander-like, from it into the gravels.
4. Waiting till the water pessure is reduced to a safe point (not more than 4 lb. to the square inch) before attempting to enter the gravels on any bigger scale—even for the laudable purpose of more rapid drainage; as one false or ill-advised step at this stage may lose one the whole mine.
5. The putting up of a first tentative "raise" into the gravels—the greatest caution being exercised in this, the actual entry of the gutter itself.
6. A probable pause for further drainage—now much accelerated by the "raise."
7. The blocking out and mining of the gravels by inside mining.

I might conclude this short account by referring to one or two modifications of the Australian system that have suggested themselves during my experience with Canadian conditions.

First of all, it seems probable that

up to the depths reached by most deep leads, a dipping tunnel (not more than one in three), driven in the rim rock, might be better than a vertical shaft; and for the following reasons: (1) Lower initial capital outlay. (2) Easier and safer transport of men and materials. (3) Lower maintenance costs. (4) Greater ease in handling pumps.

For similar reasons, the raises (which are kept strictly vertical in Australian practice) might also, perhaps, be inclined at an angle. If this angle were made such that it would permit the working of a self-acting haulage scheme, its great advantages would seem obvious. That, however, is still largely a matter of experiment; and probably the first, crucial raise put up into the gravels in any new deep lead would preferably be a vertical one even if it was decided to make the subsequent ones inclined. (Only those who have opened up a deep-lead channel can know the drama of that first carefully nursed "raise.")

Finally, any other improvements in connection with the mechanical handling of the gravels from the face to the surface should not be overlooked, especially when it is realized that, in this class of mining, over one-third of the total production costs are a charge on labor. A deep-lead glossary follows.

Glossary of Deep-Lead Mining Terms

Bedrock: In Australia the stratum upon which the wash dirt rests is usually called bedrock. It usually consists of granite or boulder clay (glacial) and, much more rarely, basalt. When the strata consists of slates or sandstones (Silurian or Ordovician), it is usually called reef rock.

Block: A pillar of wash dirt usually occupying an area of 250 square fathoms surrounded with drainage cutting-up drives, ready to be mined out and treated for its gold content.

False bottom: In Australia it is usually an argillaceous horizontal stratum sufficiently solid to support auriferous wash dirt. In some of the deep leads several false bottoms may be sunk through before reaching the main stratum of auriferous wash dirt lying on bedrock.

False set: A light temporary lagging set of timber supporting the side and roof lagging until the drive is advanced sufficiently to allow the heavy permanent set to be put in, when the false set is taken out and used again in advance of the permanent set.

Gutter: The lowest portion of a deep lead filled with auriferous wash dirt.

High reef or rim rock: The bedrock or reef rising from the gutter and forming the slopes of the ancient valley.

Laths or lagging: Pieces of timber about 4 ft. 6 in. by 6 in. by 2 in. with one end sharpened or beveled to give the lath an upward trend when being driven into the roof gravels. A number of laths driven into the roof form a protective shield for the miners working in the face.

Deep lead (pronounced "leed"): A deep alluvial auriferous deposit or gutter, a hundred feet or more from the surface. Its course cannot always be determined by the trend of the present streams.

Main drive or main reef drive: A main tunnel driven in the rock underlying a "lead" and about 50 ft. below the wash dirt. It is used as a drainage tunnel for carrying the water from the drainage holes to the shaft sump and also for the transport of cars from the "raises."

Rise ("raise" in many places): A vertical or inclined shaft from a lower to an upper level. In deep-lead mining the rise is usually divided into two compartments—namely, a man way and a gravel chute. The gravel from the working faces in the deep lead is taken by cars to the top of rise and dumped into the chute. The loading of cars in the main reef drive at the bottom of the rise is controlled by a sliding door actuated by a lever.

Teasing rods: Light iron rods, about 2 ft. long, hinged together to form one continuous length of 40 to 60 ft. They are pushed up inside a drainage bore-hole casing to clear stoppages of pebbles and gravel away, thus allowing the drainage water to flow freely.

Tubing rose: The leading piece of a set of bore-hole casing for tapping water from a deep lead, usually six feet long, and pierced with 40 to 50 holes, and several slots. A driving shoe about 7 in. long, with a hole through the middle, is fitted securely into the top end.

Drill Hole as Power-Cable Conduit

RECENTLY, the engineering department of Lava Cap Gold Mining Corporation, operating the Central and Banner mines, near Nevada City, Calif., was confronted with a power installation problem, writes Otto E. Schiffner, vice-president and general manager. Carrying out a general expansion program, the company recently drove a 6,000-ft. tunnel from the surface to connect the two mines, and cut an underground station preparatory to sinking a three-compartment shaft from the new tunnel level. This station is about 500 ft. vertically below the surface, and is large enough to accommodate a 150-ft. double-drum hoist, a 1,700-cu.ft. compressor, transformer equipment, and two 75-hp. pumps if conditions should warrant their installation. To provide electric power for this machinery, three Pyranol-filled transformers were purchased and set up in the station.

Comparison Costs

Drill-Hole Method	
526 ft. of 11,000-v. cable @ $1	$526.00
445 ft. of diamond-drill hole	1,637.00
Cost of sinking shaft 34 ft. to bedrock	220.49
Miscellaneous costs and labor installing pole, switch, etc.	187.15
Total cost	$2,571.14
Cable Through Tunnel	
6,000 ft. of three-conductor cable	$6,000.00
Labor and supplies installing cable in tunnel	1,000.00
Total cost	$7,000.00

Next, the problem of getting electricity cheaply and safely to the transformers had to be solved. After study it was decided to do this by means of a diamond-drill hole extending from the surface to the station roof. Fortunately, the power line on the surface carrying 11,000 volts followed the general direction of the new tunnel, which further supported the belief that execution of the scheme would result in saving much money and provide maximum safety.

Accordingly, a 2¾-in. diamond-drill hole was drilled and a 2⅛-in. three-conductor, lead-covered cable of the suspension type was dropped through it. The cable is suspended from a set of clamps on the surface as indicated in the cut. Power received at 11,000 volts is stepped down to 440 volts by the three transformers in the underground station.

The table gives a comparison of the cost of the method described with that of introducing the cable in the conventional way, through the tunnel:

Actual costs are given for the drill-hole method. A saving of about $4,500 is indicated, apart from the fact that by introducing the power cable through a diamond-drill hole the danger of rupture through mine car or locomotive accidents and of electrocution is eliminated.

Combating Silicosis

In New York State

State Department of Labor seeks to determine practical methods of protection against all dust hazards — Three devices so far approved for collecting dust in dry method of rock drilling

H. C. Chellson
Assistant Editor

SAFETY-FIRST PROGRAMS in this country are rapidly becoming welded to a serious industrial and legislative conciousness that seeks to protect the worker's lungs as well as his limbs. The last few years have witnessed the broadest mobilization of concerted effort by State legislatures and labor departments, insurance companies, industry, scientists, and engineers, to enlighten the public toward a more intelligent understanding of silicosis and how to combat it. Much has been done already, but most observers believe continued scientific research in many countries will in the future produce concrete data on methods and equipment that may eventually prevent this industrial disease. Meanwhile, many mining companies in this country, with the cooperation of the Bureau of Mines, have contributed factual data from their long experience involving improved methods of ventilation, employing water sprays, and wet drilling to reduce dust in metal mines.

Mining companies in South Africa have been studying the problem for more than a quarter of a century. Many operators of enterprises where rock drilling is employed are anxious to comply with the demands set forth in laws, or prepare themselves pending proposed laws, but their knowledge and understanding of means to protect against the dust hazard is often somewhat hazy. In this connection the Bureau of Mines has available a new comprehensive book, Bulletin 400, "Review of Literature on Effects of Breathing Dusts, With Special Reference to Silicosis," by D. Harrington and Sara J. Davenport. It supplies much valuable information for mine operators, engineers, and industrial executives interested in the problem. The Air Hygiene Foundation of America, Inc., Pittsburgh, Pa., an organization of employers, is doing considerable research in virtually every phase of the dust menace.

Growing interest in silicosis legislation is indicated in Table I, which lists the States that have laws now compensating for the disease. States that have created commissions for the purpose of studying occupational diseases and recommending legislation therefor are Alabama, Arizona, Georgia, Maine, Maryland, New Mexico and Oregon.

Table I—States Allowing Compensation for Silocosis

(Year indicates passage of industrial compensation act)

1919 California	1934 Kentucky
1919 Wisconsin	1935 North Carolina
1925 North Dakota	1935 West Virginia
1927 Connetcicut	1936 Illinois
1930 New York	1937 Indiana
1931 Ohio	1937 Michigan
1931 Missouri	1937 Pennsylvania
1932 Massachusetts	1937 Washington

The campaign in New York State for combating silicosis by preventive measures has probably attracted broader general interest in the rock-drilling field because it is the only State that has pioneered in setting up standards for investigating methods and equipment that fulfill requirements set by the Industrial Board. Factual data incorporated in these rules were adopted by the board after being set by an advisory committee consisting of representatives from the medical profession, Department of Labor officials, and special representatives of labor and industry. Part of these rules are summarized herewith.

1—"Any rock formation of substantially uniform geological character having free silicon dioxide as a component part which is known from geological studies or otherwise can be shown by the applicant (rock drilling employer) to the satisfaction of the Industrial Commissioner, to run uniformly less than ten (10) per cent by weight of the rock formation.

2—"All rock formations having free silica dioxide as a component part, ten (10) per cent or more by weight, and all other formations, natural and synthetic, having a variable and unpredictable content of free silicon dioxide."

The rules define "injurious silica dust concentration" as "dust produced from drilling silica-bearing rock which is in excess of the following values as determined by an approved dust count method:

1—"One hundred million (100,000,000) particles per cubic foot of air (as specified in No. 1 above).

2—"Ten million (10,000,000) particles (as specified by No. 2 above)."

All rock-drilling operations must be executed so that there will be no dissemination of injurious silica dust concentration into the atmosphere. Dust control may be effected by suction or exhaust, and wet methods when approved by the Industrial Board, and other methods which may be invented or developed in the future, providing they are approved by the Board.

Silicosis became a compensable disease in New York State on Sept. 1, 1935. The Labor Department established a field laboratory in a granite outcropping at Letchworth Village, in Rockland County, where dust-control devices were tested for official approval. On April 27, 1937, the rules relating to the control of silica dust in rock drilling were adopted by the Industrial Board and became effective May 1, 1937. On July 1, 1937, the Legislature created the Board of Standards and Appeals, assigning to it the rule-making and interpreting functions formerly invested in the Industrial Board. Under the requirement, three dust-control devices of the dry suction type have so far been approved by the Board. These are given in Table II.

Complete equipment of the Spencer Turbine Drill-Vac portable unit under Approval 2249 consists of the following: One exhaust hood for each drill; exhaust has 2-in. internal diameter for jackhammers and stopers and 2½-in. internal diameter for use with drifter. Two lengths of hose, 37.5 and 12.5 ft., are provided from the hood to the cyclone to the filter compartment. The hood is cast steel, cylindrical in shape, about 7 in. diameter, 4½ in. high, with top covered with rubber having a central opening 1¼ in. diameter for passage of drill steel. A baffle within the hood is provided to insure proper movement of the air for efficient dust collection. A vacuum fan and motor are also furnished.

Two stages of separation are employed. The first stage consists of individual cyclone separators for each drill in the form of a cylindrical chamber 16 in. in diameter for use with jackhammer or stope hammer of 2⅝-in. bore, and 24-in. diameter cylinder for the 3½-in. drifter.

The dust-separating efficiency is said to be 95 per cent. Dust-storage capacity of the cyclone is 3.5 cu.ft. for the smaller primary and 7 cu.ft. for the larger primary tank. The second stage or filter compartment is connected to each of the cyclones by a hose. In this unit the filter chamber is cylindrical and varies in size with capacity. The vacuum fan is connected to the filter by means of an iron pipe of sufficient dimensions not to introduce a significant pressure loss

Table II—List of Dust-Control Equipment Approved by New York State Industrial Board

Device	Approval No.
Spencer Turbine Company, Hartford, Conn.	
Model P Drill-Vac Dust Collector (multiple-drill, portable type) for 2, 4, 7, 9, 14, or 19 drills using 2⅝-in. jackhammer or stope hammer or 1, 2, 3, 4, 7, 9 drills using 3½-in. drifter	2249
Model S Drill-Vac Dust Collector (multiple drill type) for 2, 4, 7, 9, 14, 19, 24 drills using 2⅝-in. jackhammer or stope hammer or 1, 2, 3, 4, 7, 9, 12 drills using 3½-in. drifters	2250
Model A 2-Drill-Vac Dust Collector. Capacity, 2 jackhammers, 2 stope hammers, or 2 drifters	2251
Model A Drill-Vac Dust Collector. Capacity 1 2⅝-in. jackhammer, 1 2⅝-in. stope hammer	2212
Kadco Corporation, 42 Rockefeller Plaza, New York City	
12-Drill Unit Kadco Dust Collector. Capacity, 12 2⅝-in. jackhammers, 12 2⅝-in. stope hammers, or 5 3½-in. drifters	2210
2-Drill Unit, Kadclone Dust Separator. Capacity, 2 2⅝-in. jackhammers and 2 2⅝-in. stope hammers	2207
5-Drill Unit, Kadco Dust Collector. Capacity, 5 2⅝-in. jackhammers, 5 2⅝-in. stope hammers, or 2 3½-in. drifters	2211
1-Drill Unit, Kadclone. Capacity, 1 jackhammer, maximum bore, 2⅝-in	2276
2-Drill Unit, Special No. 2 Kadclone. Capacity 2 jackhammers or 2 stope hammers, maximum bore, 2⅝-in	2252
3-Drill Unit, Kadco Dust Collector. Capacity, 3 jackhammers; 2⅝-in. bore; 3 stopers, 2⅝-in. bore; or 1 drifter. Maximum bore, 3½-in	2208
4-Drill Unit, Kadco Dust Collector. Capacity, 4 jackhammers or stope hammers; maximum bore, 2⅝-in. Any combination of jackhammers or stope hammers (maximum bore 2⅝-in.) not to exceed total of 4 drills. Two drifters, bore 3½-in. and 1 jackhammer or stope hammer, maximum bore 2⅝-in	2230
Kadclone Special 2-A Unit. 2 2⅝-in. drills or 1 4-in. drill	2282
Markley Dust Control System, 61 Broadway, New York City	
2-Drill Dust Collector. Capacity 2 jackhammers; maximum bore 2⅝-in	2229
1-Drill Dust Collector; capacity, 1 jackhammer; maximum bore, 2⅝-in	2281

Table III—Model List of Spencer Turbine Company

N. Y. Approval No.	M'frs.' Model No.	Motors, hp.	Number of Jackhammers or Stopers	Number of Drifters or Wagon Drills
2212				
	A-1	1	1	—
2251				
	A-2	2	2	—
	A-2Z	2	2	1
2249				
	P-2	3	2	1
	P-4	5	4	2
	P-7	7½	7	4
	P-9	10	9	5
	P-14	15	14	7
	P-19	20	19	10
2250				
	S-2	3	2	1
	S-4	5	4	2
	S-7	7½	7	4
	S-9	10	9	5
	S-14	15	14	7
	S-19	20	19	10
	S-24	25	24	12

and may be belt-driven by a gasoline engine or directly by an electric motor. Motor horsepower and other data are shown in Table III.

Equipment by the Kadco Corporation, 45 Rockefeller Plaza, New York City, under New York State Department of Labor Approval 2230, lists the following essential parts for the four-drill Kadco unit: (1) Exhaust hoods (four for jackhammers or stope hammers, two for drifters). (2) Exhaust hose lines (with special piping and manifolds in certain cases) leading from the exhaust hoods to the collector. (3) Kadco Standard Dust Collector No. 4, and vacuum fan and engine.

Various types of hood are available, depending on the drill used. A pot-type hood for 2⅝-in. jackhammer is of welded black iron construction of truncated cone design, 9 in. in diameter at the base, 5 in. at the top, and 5½ in. high. A 2⅛-in. side outlet is provided on the hood for exhaust hose connection, and internal baffles guide the dust to this outlet. The hood is split and hinged to permit its being placed around the drill steel, and spring hinges and a latch keep the hood closed during operation. In the pot-type hood the required rate of air flow through the hood specified by the manufacturer is 90 cu.ft. per minute and for the bell-type hood for 3½-in. maximum bore drifter, 175 cu.ft. per minute. Exhaust hose is furnished in 25-ft. lengths with four lengths, or 100 ft., provided for each drill.

Kadco Standard Dust Collector No. 4 consists of three stages of separations arranged in a single steel housing. Dust-laden air enters the first stage separator through a nozzle at 1,800 ft. per minute and strikes a baffle which deflects the flow downward. The air reverses its direction when passing into the entrance nozzle of the second-stage separator; and the change in direction is said to deposit about 85 per cent of the dust. The second stage of separation consists of high-velocity impingement into a closed chamber at a velocity approximately 4,800 ft. per minute, followed by complete and sudden reversal of direction and escape of the air through special trapping baffles. Approximately 10 per cent of the total dust collected is said to be deposited in the second-stage compartment. The filter compartment follows the second-stage separator.

Markley Dust Control System, Inc., 61 Broadway, New York City, has approval No. 2229 for the following equipment of capacity for two jackhammers, maximum bore 2⅝ in: (1) Exhaust hoods at the drills. (2) Exhaust hose leading from hoods to the collector. (3) Markley dust collector. (4) Vacuum pump and engine.

The hood employed is the Markley pot type of welded black-iron construction, cylindrical in shape, 6 in. in diameter and 4 in. high, with a side outlet 1½ in. outside diameter. The top of the hood is of thick rubber and is provided with a central opening 1⅛ in. diameter for passage of the drill steel. At the side the hood has the feature of being cut away and closed with a split rubber wall section 2½ in. wide. The rubber top piece is also split to the center, thus allowing the hood to be incased around the drill steel and removed at will. Hoods are also provided for line and angle drilling. Air flow required through the hood as specified by the manufacturer is 80 cu.ft. per minute. Reinforced exhaust hose is supplied from the hood to the primary separator in lengths to meet operating conditions, but the total length of hose from the hood to the filter compartment shall not exceed 55 ft.

The dust collector consists of two parts: two primary cyclones, one for each drill, followed by a filter compartment. Each cyclone is cylindrical in shape, 16 in. diameter, and 3 ft. high, surmounted by the cyclone section consisting of a cylinder 13½ in. in diameter and 8 in. high. A removable fiber container is provided, into which the dust is deposited. The efficiency of the cyclone is said to be 97 per cent. The filter compartment is connected to the primary separator

Table IV—Important Dimensions of 4-Drill Kadco Dust-Control Unit

Dimensions of housing, in.	48x62x58
Inlet nozzle velocity, f.p.m.	1800
First-stage efficiency, per cent	80-90
First-stage storage capacity, cu. ft.	19.0
Minimum storage capacity required (*), cu. ft.	8.0
Second-stage nozzle velocity, f.p.m.	4,700
Second-stage efficiency, per cent	10
Second-stage storage capacity, cu. ft.	10
Minimum storage capacity required (*), cu. ft.	0.9
Total filter area, sq. ft.	210
Minimum filtering velocity, ft. per min.	2.14
Filter storage capacity, cu. ft.	4.0
Minimum storage capacity required (*), cu. ft.	0.5
Total air flow (jackhammer and stope hammer), cu. ft. per min.	450
Air flow per drill (jackhammer and stope hammer), cu. ft. per min.	100
Static suction at collector inlet (100 ft. 2⅛-in. per drill)	1.25 in. mercury
Total air flow (drifter), cu. ft. per min.	350
Air flow per drill (drifter), cu. ft. per min.	175
Static suction at collector inlet (100 ft. 2⅛-in. hose per drill)	4.0 in. mercury
Fan capacity	350 r.p.m. at 3.5 in. mercury
Fan speed, r.p.m.	4,000
Engine h.p.	7 to 12

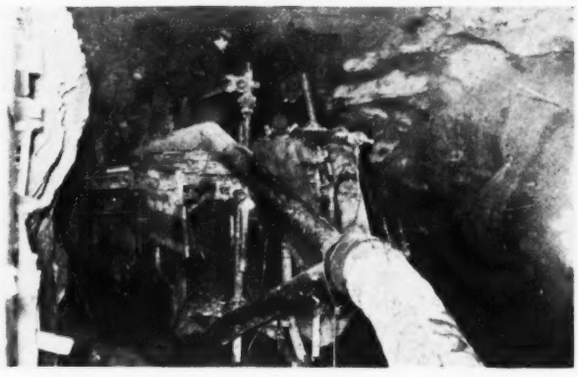
(*) Based on 4 hours' storage at rate of 144 ft. drilling per day; average discharge hole 2 in.; 60 voids in dust.

Fig. 1 (above) . . . TWO JACKHAMMERS are here employed with a portable gasoline-driven Spencer Turbine dust collector

Fig. 2 (at left top) . . . A KADCO four drill portable dust collector gasoline-driven machine

Fig 3. (bottom left) . . . TWO WAGON DRILLS in operation, one has hood over the hole; the other, on right near the Markley dust control equipment, is drilling without hood

Fig. 4 (below) . . . SIX WET DRIFTER DRILLS are mounted on front of this jumbo. The four 10 in. steel ventilation pipes join the large canvas tubing that is connected to a centrifugal fan unit sucking dust from the heading



by means of 1½-in. hose. Filter housing is 29 in. in diameter and 52½ in. high. Sixty square feet of filter is provided in the form of a single bag to prevent collapse during operation.

The vacuum pump is of a positive-displacement type of 160-cu.ft. per minute capacity at 4.0 in. mercury when driven at 1,380 r.p.m. Gasoline, air, or electric power may be used of sufficient capacity to operate the pump at 1,380 r.p.m. and create an air flow of 160 cu.ft. per minute at a resistance of 4 in. mercury. A driving motor of 3 hp. is required.

Seeking to determine a convenient and practical method of dust control in wet drilling, a group of subway contractors in New York City, under the direction of Benjamin F. Tillson, consulting mining engineer, Montclair, N. J., recently developed a device employing ventilation that is said adequately to reduce the dust count below the minimum safe limit of ten million particles (under 10 microns) per cubic foot of air established by the New York code. This apparatus is shown in Fig. 4. The drill carriage illustrated has six pneumatic-feed drifter drills, arranged in three pairs, two at the top above the rack, two at the center, and two at the bottom. The four large tubes appearing to grapple the jumbo are 10-in. diameter steel ventilating pipes that extend from the working zone of the drillers to the manifold seen at the rear, where it connects to a 20-in. non-collapsible, flexible canvas tubing. Air is sucked through the tubing by means of a specially designed 16-in. diameter centrifugal fan attached to a 10-hp. motor unit that is located well in back of the jumbo.

At the fan outlet a 1-in. water line feeds into the centrifuge about 5 gal. of water per minute that mixes with the incoming air and traps the dust. The high speed of the fan blades throws the dust and water into a side ring that passes the material off into a drain, while the effluent air is passed to an exhaust pipe. Grab samples by a konimeter are said to have shown a satisfactory low dust count in the effluent air. A filter unit has been designed by this group that will discharge the exhaust air into the heading after passing through a series of oiled filter papers. The New York Industrial Board has, however, not yet approved equipment or methods used in connection with wet drilling. Standards were established, however, on Jan. 21, 1938, by E. F. Andrews, Industrial Commissioner, for testing of devices covering equipment employing wet methods of dust control. Generally, they follow methods now in use in some metal mines, except that they specify the volume of water that should flow through the various sized drills. Water must be used when collaring the hole and the valve in the water line shall be of such design that it has only two fixed positions—namely closed or completely open. The standards also specify that six months after date of approval all wet drills shall be equipped with a combination air throttle and water valve of such design that the required rate of water flow through the drill steel will be insured whenever the air throttle is in the operating position half speed as well as full speed. Positive-pressure ventilation or exhaust ventilation may be used to remove air from the entire drilling area in a manner satisfactory to the Industrial Commissioner. Tests for wet methods are expected to be made soon.

NEW BOOKS

ECONOMIC GEOLOGY. *By H. Ries. Seventh Edition. John Wiley & Sons, 1937. Pp. 720. Price $5.*

PROFESSOR RIES'S TEXTBOOK on Economic Geology is so well known that a review of the seventh edition hardly seems necessary. The general plan and organization of the material is, on the whole, similar to that of previous editions. Both the subject matter and references are brought up to date as nearly as possible in a book of this kind. Probably the most notable changes are to be found in the chapter on Petroleum, Natural Gas, and Other Hydrocarbons, which has been revised and largely rewritten. Sub-Surface Waters and Silver-Lead Ores, both of which were treated in separate chapters of the former edition, are now included among other of the chapters on Ore Deposits. Another distinct departure is the inclusion of graphs, instead of statistical tables, showing the trends in production of mineral products over a period of years.

Part I is devoted to the non-metallic mineral products and includes excellent discussions of the origin, properties, distribution, and uses of this important group. Part II is devoted to metallic ores, with a chapter on processes of origin and classification, followed by more detailed discussions of iron, copper, lead and zinc, gold and silver, and minor metals. Each chapter contains a well-selected bibliography of the literature pertaining to the subject taken up in that chapter. The volume is, as usual, very well illustrated.

The book contains 140 fewer pages than the previous volume. This has been achieved, not by condensation of the subject matter, but by increasing the number of words to a page, thus making a slightly smaller volume than former editions.

This edition maintains the high standard that the book has always enjoyed, both as to the treatment of the subject and printing, and it will undoubtedly continue to be widely used as a text and reference for students of economic geology.

PHILIP KRIEGER

MINING YEAR BOOK, 1938. *Compiled and published by Walter E. Skinner, 15 Dowgate Hill, London, E.C.4. Pp. 1060. Price 20s. net; 21s.6d. Post free abroad.*

THIS is the fifty-second annual issue of the international standard reference work on mines. It contains full particulars of 1325 of the world's principal mining companies, together with lists of directors and mining and consulting engineers. A useful feature is 25 sketch maps inserted throughout the book facing the particulars of the various companies, covering the Central, Western, and Far Eastern Rand and the principal properties in West Africa and Western Australia. Every effort has been made to maintain the long-established reputation of the book for completeness and accuracy.

XV YEARS SOCIALIST INDUSTRY SERVICE. Vol. II. *Institute of Ore Dressing "Mechanobr." Vasilievsky Ostrov 21, Leningrad 26. U.S.S.R. Pp. 429.*

RUSSIAN ENGINEERS employed in metallurgical research take particular interest in having results of their experiments printed and sent to all parts of the country to enlighten their less experienced brothers in the operating field. Printed in Russian, with a brief summary in English, the book has fourteen chapters, some of which are descriptions of ore-dressing plants treating manganese, bauxite, and iron ore. Results of ore-dressing experiments on Magnitogorsk iron ores, and titanium ores at Pudozhgorsk, and flotation tests at Zangezur on the copper-lead-zinc ores from Shoumyansk for determining proper flowsheet, are also given.

A DESCRIPTIVE PETROGRAPHY OF THE IGNEOUS ROCKS. Vol. IV. *By Albert Johannsen. University of Chicago Press, Chicago, Ill. Pp. 523. Price $4.50.*

WHETHER they agree with his classification or not, petrographers the world over will join in congratulating Professor Johannsen on the completion of his great undertaking. There was a time when it seemed that the enthusiasm and the assiduity needed to produce a work of this size had died with Zirkel and Rosenbusch; but during the thirty years that have passed since Rosenbusch died Professor Johannsen has been quietly compiling the monumental work that now lies finished before us.

The new volume, of 523 pages, maintains the high standard of the earlier ones and follows the same now familiar plan. It treats the feldpathoidal rocks in great detail (393 pages) and dismisses the peridotites and perknites in a mere 74 pages. This is all to the taste of the reviewer, who has never dissembled his love for the feldpathoids, but to others it may suggest a certain lack of proportion. The very complete indexes of authors, localities, and rock-names cover the contents of volumes II and III as well as the present volume. It is with mixed feelings that one counts no less than 384 rock-names of the purely geographic type in the index, and notes that 28 of them are new names which make their first appearance in this volume. It is true that the new names are more clearly defined than many of the old ones, since each of them corresponds to a definite pigeonhole in Johannsen's classification and can be represented by a symbol, but they are not likely to be hailed with joy by petrographers. *Bogusite* sounds too good to be true, or maybe too true to be good. *Deilite* is one of those little jokes that Professor Johannsen loves to spring upon us when he thinks we are too serious (see the end-paper of Vol. I).

With 37 names to his total score, Professor Johannsen has now left all competitors behind except Lacroix and Brögger. In spite of this we must admit that Professor Johannsen has made a brave fight to bring order into petrography, and for that he deserves our admiration and gratitude.

S. J. SHAND.

QUIN'S METAL HANDBOOK AND STATISTICS, 1938. *Metal Information Bureau, Ltd., London. Pp. 337. Price 5s. 6d.*

THIS is the twenty-fifth annual edition and contains the usual compilation of price information and production data on ferrous and nonferrous metals. The tin statistics have been expanded in the latest edition and additions have been made to the annual record of steel prices.

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PUBLICATIONS

RECEIVED

✦ *New South Wales Department of Mines.* Annual Report 1936. Sydney, Australia. Pp. 128.

✦ *The Canadian Mineral Industry in 1936.* Reviews by the staff of the Bureau of Mines. Bulletin No. 786. Ottawa. Pp. 78. Price, 25c.

✦ *The Transportation of Sand in Pipe Lines.* By M. P. O'Brien and R. G. Folsom. University of California Press, Berkeley, Calif. Pp. 37.

✦ *Kodiak and Vicinity, Alaska.* By Stephen R. Capps. Bulletin 868-B, U. S. Geological Survey. Sold by Superintendent of Documents, Washington, D. C. Pp. 42, with map. Price 25c.

✦ *Geology and Archaeology of Vaal River Basin.* By P. G. Söhnge and C. Van Riet Lowe. Memoir No. 35. Geological Survey, Union of South Africa. Pretoria, Pp. 192. Price 5s.

✦ *Geology of Rotorua-Taupo Subdivision, Rotorua and Kaimanawa Divisions.* By L. I. Grange, Bulletin 37. Geological Survey, Wellington, New Zealand. Pp. 138 and maps. Price, paper, 14s., postage extra.

✦ *Water-Bearing Properties of the More Important Geological Formations in the Union of South Agrica.* By H. F. Frommurze. Memoir No. 34. Geological Survey, Union of South Africa, Pretoria. Pp. 186. Price 5s.

✦ *Geology and Mineral Resources of the Baker Quadrangle, Oregon.* Bulletin 879. U. S. Geological Survey and Oregon State Mining Board. Sold by Superintendent of Documents, Washington, D. C. Pp. 119, with map. Price 65c.

Summary of the

MARKETS

THOUGH a moderate seasonal upturn in consumption of non-ferrous metals occurred during March, the gains were so slight that the price structure failed to respond to this improvement. Purchases were smaller than in February. Our index of prices for March was 72.41, which compares with 73.43 in February and 103.78 in March last year. Monthly averages for lead, zinc, tin and foreign silver were lower than in the preceding month.

Copper in the domestic market was unchanged on the 10c. Valley basis throughout the month. Sales for the month totaled 22,012 tons, which compares with 23,518 tons in February and 25,543 tons in January. Estimates on actual consumption of copper at fabricating plants are said to show a more favorable trend. The disappearance of copper in January was placed at about 32,000 tons, whereas the figure for February was nearer 37,000 tons. Stocks of copper in the hands of fabricators are being reduced, but supplies held by domestic producers have been increasing, totaling 326,244 tons at the end of February, against 299,133 tons a month previous. A supporting factor in domestic copper has been the continued activity in the European market. The foreign price was a fraction of a cent under the domestic basis most of the month and "weak" domestic metal found takers abroad.

Statistically, lead remains in a relatively good position, and producers experienced no difficulty in maintaining the price at 4.50c., New York.

Output of zinc remains excessive under present conditions, and this accounted for the reduction in the price of Prime Western to 4.25c., St. Louis.

Tin was under pressure in Singapore and London. The quotation for Straits dropped to 38c., New York.

Developments in Mexico caused the Treasury to lower its buying quotation on foreign silver 2c. per ounce.

UNITED STATES MARKET

1938	Electrolytic Copper, Domestic (a)	Electrolytic Copper, Export (b)	Straits Tin, New York	Lead, New York	Lead, St. Louis	Zinc, St. Louis
Mar.						
1	9.775	9.600	41.875	4.50	4.35	4.75
2	9.775	9.625	42.000	4.50	4.35	4.75
3	9.775	9.625	41.750	4.50	4.35	4.75
4	9.775	9.650	41.875	4.50	4.35	4.75
5	9.775	9.650	41.750	4.50	4.35	4.75
7	9.775	9.650	41.750	4.50	4.35	4.75
8	9.775	9.575	41.750	4.50	4.35	4.75
9	9.775	9.575	42.000	4.50	4.35	4.50
10	9.775	9.550	41.750	4.50	4.35	4.50
11	9.775	9.500	41.000	4.50	4.35	4.50
12	9.775	9.475	41.000	4.50	4.35	4.50
14	9.775	9.500	41.125	4.50	4.35	4.25
15	9.775	9.600	41.750	4.50	4.35	4.25
16	9.775	9.650	41.400	4.50	4.35	4.25
17	9.775	9.575	41.500	4.50	4.35	4.25
18	9.775	9.525	41.250	4.50	4.35	4.25
19	9.775	9.525	41.500	4.50	4.35	4.25
21	9.775	9.525	41.500	4.50	4.35	4.25
22	9.775	9.500	41.375	4.50	4.35	4.25
23	9.775	9.350	41.000	4.50	4.35	4.25
24	9.775	9.375	41.250	4.50	4.35	4.25
25	9.775	9.425	41.250	4.50	4.35	4.25
26	9.775	9.450	41.250	4.50	4.35	4.25
28	9.775	9.325	40.750	4.50	4.35	4.25
29	9.775	9.325	40.500	4.50	4.35	4.25
30	9.775	9.175	39.000	4.50	4.35	4.25
31	9.775	9.100	38.000	4.50	4.35	4.25
Monthly Average	9.775	9.496	41.219	4.500	4.350	4.417
Mar.	AVERAGES FOR WEEK					
2	9.775	9.704	42.104	4.500	4.350	4.750
9	9.775	9.621	41.813	4.500	4.350	4.708
16	9.775	9.546	41.338	4.500	4.350	4.375
23	9.775	9.500	41.354	4.500	4.350	4.250
30	9.775	9.346	40.667	4.500	4.350	4.250
Mar.	CALENDAR WEEK AVERAGES					
5	9.775	9.638	41.875	4.50	4.35	4.750
12	9.775	9.554	41.542	4.50	4.35	4.583
19	9.775	9.563	41.421	4.50	4.35	4.250
26	9.775	9.438	41.271	4.50	4.35	4.250

SILVER, GOLD, AND STERLING EXCHANGE

NEW YORK AND LONDON

1938	Sterling Exchange, "Checks"	Sterling Exchange, "90-day demand"	Silver, (c) New York	Silver, London	Gold, London	Gold, (d) United States
Mar.						
1	5.01625	5.00875	44.750	20.0625	139s 9½d	$35.00
2	5.01625	5.00875	44.750	20.0625	139s 10 d	35.00
3	5.01625	5.00875	44.750	20.1875	139s 9 d	35.00
4	5.01500	5.00750	44.750	20.2500	139s 9½d	35.00
5	5.01125	5.00375	(e)	20.3125	139s 9 d	35.00
7	5.00625	4.99750	44.750	20.2500	139s 8½d	35.00
8	5.01625	5.00750	44.750	20.0625	139s 7½d	35.00
9	5.01375	5.00500	44.750	20.1250	139s 7 d	35.00
10	5.01125	5.00250	44.750	20.1875	139s 6½d	35.00
11	5.00500	4.99750	44.750	20.3125	139s 6½d	35.00
12	4.99500	4.98625	(e)	20.3750	139s 8 d	35.00
14	4.98625	4.97750	44.750	20.3125	139s 8 d	35.00
15	4.97625	4.96750	44.750	20.3750	139s 8½d	35.00
16	4.96750	4.95875	44.750	20.3750	139s 9½d	35.00
17	4.96875	4.96000	44.750	20.5000	140s ½d	35.00
18	4.95500	4.94625	44.750	20.5625	140s 2½d	35.00
19	4.96375	4.95500	(e)	20.5625	140s 5½d	35.00
21	4.96000	4.95125	44.750	20.4375	139s 11½d	35.00
22	4.96625	4.95750	44.750	20.4375	140s 2 d	35.00
23	4.96375	4.95500	44.750	20.3125	140s 1½d	35.00
24	4.96000	4.95125	44.750	20.3750	140s 1½d	35.00
25	4.95750	4.95000	44.750	20.3750	140s 2 d	35.00
26	4.95500	4.94625	(e)	20.3750	140s 3½d	35.00
28	4.95750	4.95000	43.750	19.6250	140s 3 d	35.00
29	4.97500	4.96750	42.750	18.3750	139s 11 d	35.00
30	4.96625	4.95875	42.750	18.3750	139s 11 d	35.00
31	4.96500	4.95750	42.750	18.8125	140s ½d	35.00
Average for Month	4.98394	.....	44.446	20.088	.....	35.00
Mar.	AVERAGES FOR WEEK					
2	5.01750	.....	44.750	.....	.....	.....
9	5.01313	.....	44.750	.....	.....	.....
16	4.99021	.....	44.750	.....	.....	.....
23	4.96292	.....	44.750	.....	.....	.....
30	4.96188	.....	43.750	.....	.....	.....

Calendar week averages: New York Silver March 5th, 44.750; 12th, 44.750; 19th, 44.750; 26th, 44.750.

THE above quotations for major non-ferrous metals are our appraisal of the important United States markets, based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

(a) Net prices at refineries on Atlantic seaboard. To arrive at the delivered New England basis, add 0.225c. per pound, the average differential for freight and delivery charges.

(b) Export prices are net at refineries on the Atlantic seaboard and include sales of domestic copper in the foreign market. Most sales in the foreign market are made on the basis of c.i.f. usual ports of destination—Hamburg, Havre, and Liverpool. The c.i.f. basis commands a premium of 0.350c. per pound above our refinery quotation.

Copper, lead and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

Quotations for copper are for the ordinary forms of wirebars and ingot bars; cathodes are sold at a discount of 0.125c.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York commands a premium over the St. Louis basis equal to the freight differential. Contract prices for High Grade zinc delivered in the East and Middle West in nearly all instances command a premium of 1c. per pound over the current market for Prime Western but not less than 1c. over the *E. & M. J.* average for Prime Western for the previous month.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

(c) Silver other than newly mined domestic. Under Executive order effective Jan. 1, 1938, the U. S. Government's price on newly mined domestic silver was established at 64.64c. Handy & Harman's quotation for domestic silver, .999 fine, was 64½c. per ounce throughout March.

(d) U. S. Treasury's gold price. Actual payment by the United States Treasury for gold in domestic and imported ore or concentrate is at 99.75 per cent of the price quoted by the Treasury, which at present is equal to $34.9125 per ounce.

PRICES OF METALS • MISCELLANEOUS QUOTATIONS

LONDON MARKET

1938 Mar.	COPPER Standard Spot	COPPER Standard 3 months	COPPER Electro Bid	TIN Standard Spot	TIN Standard 3 months	LEAD Spot Buyers	LEAD Spot Sellers	LEAD 3 months Buyers	LEAD 3 months Sellers	ZINC Spot Buyers	ZINC Spot Sellers	ZINC 3 months Buyers	ZINC 3 months Sellers
1.....	39.7500	39.9375	43.5000	185.7500	185.2500	15.3750	15.4375	15.5000	15.5625	14.2500	14.3125	14.5000	14.5625
2.....	40.2500	40.5000	44.0000	186.5000	186.0000	15.3125	15.3750	15.5000	15.5625	14.3750	14.4375	14.6250	14.6875
3.....	40.1250	40.3750	44.5000	185.2500	184.7500	15.3125	15.3750	15.5000	15.5625	13.8750	13.9375	14.1250	14.1875
4.....	40.1250	40.4375	44.5000	185.3750	184.8750	15.2500	15.3125	15.4375	15.5000	13.8750	13.9375	14.1250	14.1875
7.....	40.1250	40.3750	44.2500	185.3750	185.0000	15.2500	15.3125	15.4375	15.5000	14.0625	14.1250	14.2500	14.3750
8.....	39.8750	40.1250	44.0000	185.5000	185.2500	15.3125	15.3750	15.4375	15.5000	14.0625	14.1250	14.2500	14.3750
9.....	39.8750	40.1250	43.6250	185.8750	185.8750	15.5000	15.6250	15.6250	15.7500	14.1875	14.2500	14.3750	14.4375
10.....	39.9375	40.1250	43.7500	185.7500	185.5000	15.3750	15.4375	15.5000	15.5625	14.1875	14.2500	14.3750	14.4375
11.....	39.3125	39.5000	43.0000	182.5000	182.5000	15.2500	15.3750	15.4375	15.5000	14.0000	14.0625	14.1250	14.2500
14.....	40.1875	40.3750	43.5000	182.7500	182.7500	15.6875	15.7500	15.8125	15.8750	14.2500	14.3125	14.3750	14.4375
15.....	41.2500	41.5000	44.5000	186.7500	187.0000	16.8750	16.9375	16.9375	17.0625	15.0625	15.1875	15.1875	15.2500
16.....	40.7500	41.0000	44.5000	185.0000	185.2500	16.4375	16.5000	16.5625	16.6250	15.1875	15.3125	15.3125	15.3750
17.....	40.6875	40.9375	44.2500	184.6250	184.7500	16.5625	16.6250	16.5625	16.6250	14.8125	14.9375	14.9375	15.0000
18.....	40.5625	40.7500	44.2500	184.5000	184.8750	16.8750	16.9375	16.9375	17.0000	14.8750	14.9375	14.9375	15.0000
21.....	40.3750	40.6250	44.0000	184.5000	184.8750	17.1250	17.1875	17.1250	17.1875	14.8750	14.9375	14.8750	14.9375
22.....	40.0000	40.2500	44.0000	185.5000	185.7500	16.7500	16.8750	16.8125	16.8750	14.6875	14.7500	14.7500	14.8125
23.....	39.1875	39.4375	43.0000	184.5000	184.7500	16.0625	16.1875	16.0625	16.1250	14.2500	14.3750	14.3125	14.3750
24.....	39.3125	39.5625	43.0000	183.5000	184.0000	16.0625	16.1875	16.1250	16.1875	14.3125	14.4375	14.3125	14.4375
25.....	39.5000	39.8125	43.2500	184.3750	184.7500	16.2500	16.3750	16.3125	16.3750	14.3125	14.4375	14.3750	14.4375
28.....	38.6250	38.8750	42.5000	183.0000	183.2500	16.3125	16.4375	16.3750	16.4375	14.1250	14.1875	14.1250	14.1875
29.....	39.0000	39.1875	42.7500	182.5000	183.0000	16.3125	16.3750	16.3125	16.3750	14.1875	14.2500	14.1875	14.2500
30.....	38.0625	38.3125	42.0000	173.0000	173.2500	15.9375	16.0000	15.9375	16.0000	13.8125	13.9375	13.8750	13.9375
31.....	37.8750	38.1250	41.7500	167.5000	167.5000	15,6875	15.7500	15.6875	15.7500	13.8125	13.8750	13.8125	13.8750
Average for Month..	39.772	.....	43.582	183.473	.....	15.992		16.075		14.364		14.477	

Prices for lead and zinc are the official prices for the first session of the London Metal Exchange; prices for copper and tin are the official closing buyers' prices. All are in pounds sterling per long ton of 2,240 lb.

CURRENT PRICES — MISCELLANEOUS METALS, ORES, AND NON-METALLIC MINERALS

Quotations cover wholesale lots, prompt shipment, f.o.b. New York, unless otherwise stated
(April 1, 1938)

MISCELLANEOUS METALS

Aluminum, ingot, 99 plus per cent, lb ..... 20c.
Antimony, domestic, spot, lb ..... 13.750c.
Bismuth, ton lots, lb $1.00
Cadmium, lb ..... 85c. @$1.20
Calcium, lb., ton lots 98 @ 99 per cent ..... 75c.
Chromium, 97 per cent grade, lb ..... 85c.
Nickel, electrolytic cathodes, lb ..... 35c.
Magnesium, 99.8 per cent, carloads, lb ..... 30c.
Palladium, troy oz $24.00
Platinum, (Official quotation) troy oz $36.00
Quicksilver, flask of 76 lb., 100 flasks or more ..... $72@$73
Radium, mg. radium content $40.00
Selenium, 99.5 per cent, lb $2.00
Silicon, minimum 97 per cent, spot, lb ..... 16.50c.
Tellurium, lb ..... $1.75@$2.00
Thallium, 100 lb. or more, lb $6.50
Titanium, 96 to 98 per cent, lb $6.00

METALLIC ORES

Beryllium Ore, f.o.b. mines, ton ..... $30.00@$35.00
Chrome Ore, 48 @ 50 per cent, c.i.f. Atl. ports, long ton ..... $24.00@$26.00
Iron Ore, Lake Superior, Lower Lake ports, long ton:
Old Range bessemer $5.25
Mesabi bessemer $5.10
Old Range non-bessemer $5.10
Mesabi, non-bessemer $4.95
Lead (Galena) 80 per cent, Joplin, Mo., ton $49.33
Manganese Ore, c.i.f. Atlantic ports, long ton unit:
52 @ 55 per cent ..... 45c.
50 @ 52 per cent ..... 45c.
44 @ 48 per cent ..... 40c.
Molybdenum Ore, 90 per cent, per lb. of contained MoS_2 ..... 45c.
Tungsten Ore, per unit of WO_3:
Chinese duty paid ..... $21.00@$22.00
Domestic, 60 per cent and upward ..... (a) $16.00@$19.00
Vanadium Ore, per lb. of contained V_2O_5 ..... 27½c.
Zinc, Ore, Prime, 60 per cent concentrate, Joplin, Mo.; per ton $28.00@$30.00
(a) Prices at mines, small lots, usually several dollars less.

METALLIC COMPOUNDS

Arsenious Oxide (arsenic) lb 3c
Cobalt Oxide, 70 @ 71 per cent, lb ..... $1.67@$1.77
Copper Sulphate, 100 lb $4.25
Sodium Nitrate, ex-vessel, in 200-lb. bags, per 100 lb $1.34
Sodium Sulphate, bulk, ton ..... $13.00@$15.00

ALLOYS

Beryllium Copper, master alloy, 2.5 to 3 per cent Bé, per lb. of contained Bé $23.00
Ferrochrome, 65 @ 70 per cent chromium, 4 @ 6 per cent carbon, lb ..... 10½c.
Ferromanganese, 78 @ 82 per cent, gross ton $102.50
Ferromolybdenum, 55 @ 65 per cent Mo. lb. of Mo contained. 95c
Ferrosilicon, 50 per cent, gross ton $69.50
Ferrotungsten, 75 @ 80 per cent, lb. of W contained $1.90

NON-METALLIC MINERALS

Asbestos, f.o.b. mines, ton:
Canadian (Quebec)
Crude No. 1 ..... $700@$750
Crude No. 2 ..... $150@$350
Spinning fibers ..... $110@$200
Paper stock ..... $40@$45
Shorts ..... $12@$16.50
Vermont
Shingle stock $57
Paper stock $40
Cement stock $25
Barytes, long ton:
Georgia, crude $7.00
Missouri, 90 per cent $BaSO_4$, less than 1 per cent iron ..... $6.00@$7.00
Bauxite, long ton:
Domestic, chemical, 55 @ 58 per cent ..... $6.50@$7.50
Domestic, abrasive, 70 @ 84 per cent ..... $12.50@$15.00
Dalmatian, 50 @ 55 per cent ..... (a) $6.50@$7.50
French, 56 @ 59 per cent ..... (a) $8.00@$9.00
China Clay, f.o.b. mines, ton:
South Carolina and Georgia, No. 1, bulk ..... $6.75@$8.00
Delaware, No. 1 ..... $14.50@.....
Feldspar, bulk, ton:
Potash feldspar, 200 mesh $17.00
Glass-spar, white, 20 mesh $11.75
Fluorspar, f.o.b. mines, bulk, Kentucky and Illinois 85–5 per cent, all rail movement, ton ..... $18@$19
Fuller's earth, f.o.b. Georgia or Florida, ton ..... $7.00@$14.00
Magnesite, per ton:
Dead-burned, f.o.b. California ..... $25.00@.....
Dead-burned, f.o.b. Washington ..... $25.00@.....
Mica, per lb., North Carolina, No. 1 and 2 quality:
1½ x 2 in ..... 15@40c.
2 x 2 in ..... 30@60c.
3 x 3 in ..... 75@$1.20
3 x 4 in ..... $1.00@$1.40
4 x 6 in ..... $2.00@$2.50
White, ground, 70 mesh, ton ..... $60.00@$80.00
Ocher, Georgia, ton ..... $19.00@$22.00
Pyrites, Spanish, per long ton unit of S, c.i.f. Atlantic ports ..... (a) 12@12½c.
Silica, water-floated, in bags, 325 mesh, ton ..... $16.00@$40.00
Sulphur, Texas mines, long ton ..... $18.00@.....
Talc, f.o.b. works, ton:
New York, double air-floated, 325 mesh ..... $12.00@$15.00
New Jersey, mineral pulp ..... $8.00@$10.00
Vermont, extra white, 200 mesh ..... $9.00@ $9.50
Tripoli, Missouri, ton:
40 mesh, cream colored ..... $15.00@.....
200 mesh, cream colored ..... $25.00@.....
(a) Nominal

IRON AND STEEL

Pig Iron, Valley furnaces, gross ton:
Bessemer $24.50
Basic $23.50
No. 2 Foundry $24.00
Steel, base prices, Pittsburgh:
Billets, gross ton $37.00
Structural shapes, 100 lb $2.25
Bars, 100 lb $2.45

Monthly and Yearly

AVERAGE PRICES

SILVER AND STERLING EXCHANGE

	New York		London Spot		Sterling Exchange	
	1937	1938	1937	1938	1937	1938
January	44.913	44.750	20.734	19.895	490.670	499.895
February	44.750	44.750	20.083	20.159	489.307	501.722
March	45.130	44.446	20.677	20.088	488.412	498.394
April	45.460	.....	20.740	.....	491.524	.....
May	45.025	.....	20.346	.....	493.835	.....
June	44.818	.....	20.022	.....	493.404	.....
July	44.750	.....	19.986	.....	496.582	.....
August	44.750	.....	19.848	.....	498.043	.....
September	44.750	.....	19.889	.....	495.145	.....
October	44.750	.....	19.942	.....	495.395	.....
November	44.750	.....	19.707	.....	499.467	.....
December	44.750	.....	18.835	.....	499.510	.....
Year	44.883	.....	20.067	.....	494.275	.....

New York quotations for silver other than newly-mined domestic, cents per ounce troy, 999 fine. London, pence per ounce sterling silver 925 fine. Sterling exchange (pound sterling) in cents.

COPPER

	F.O.B. Refinery, Electrolytic				London Spot			
	Domestic		Export		Standard		Electrolytic (a)	
	1937	1938	1937	1938	1937	1938	1937	1938
January	12.415	10.198	12.112	9.908	51.497	41.387	56.288	45.387
February	13.427	9.775	13.828	9.525	59.225	39.597	64.013	43.563
March	15.775	9.775	16.590	9.496	72.339	39.772	76.167	43.582
April	15.121	.....	14.692	.....	62.506	.....	66.614	.....
May	13 775	.....	13.999	.....	61.118	.....	63.684	.....
June	13.775	.....	13.492	.....	55.696	.....	61.409	.....
July	13.775	.....	13.817	.....	56.412	.....	62.807	.....
August	13.775	.....	13.926	.....	57.143	.....	63.595	.....
September	13.530	.....	12.984	.....	52.989	.....	58.966	.....
October	11.838	.....	11.207	.....	45.384	.....	50.619	.....
November	10.797	.....	9.850	.....	39.321	.....	44.023	.....
December	10.006	.....	9.714	.....	39.946	.....	43.886	.....
Year	13.167	.....	13.018	.....	54.465	.....	59.339	.....

New York quotations, cents per pound. London, pounds sterling per long ton, (a) Bid quotation.

LEAD

	New York		St. Louis		London			
							Spot	
	1937	1938	1937	1938	1937	1938	1938	1938
					Spot	3 Mos.	Spot	3 Mos.
January	6.000	4.870	5.850	4.720	27.272	27.150	16.135	16.253
February	6.239	4.632	6.089	4.482	28.319	28.328	15.402	15.525
March	7.190	4.500	7.040	4.350	33.027	32.979	15.992	16.075
April	6.175	.....	6.025	.....	26.014	25.878	.....	.....
May	6.000	.....	5.850	.....	24.000	23.891	.....	.....
June	6.000	.....	5.850	.....	22.878	22.759	.....	.....
July	6.000	.....	5.850	.....	23.932	23.703	.....	.....
August	6.452	.....	6.302	.....	22.606	22.670	.....	.....
September	6.400	.....	6.250	.....	20.990	21.044	.....	.....
October	5.740	.....	5.590	.....	18.259	18.318	.....	.....
November	5.033	.....	4.883	.....	16.706	16.714	.....	.....
December	4.875	.....	4.725	.....	15.905	15.994	.....	.....
Year	6.009	.....	5.859	.....	23.326	23.286	.....	.....

New York and St. Louis quotations, cents per pound. London pounds sterling per long ton.

TIN

	Straits		Standard, Spot	
	New York		London	
	1937	1938	1937	1938
January	50.925	41.548	229.350	183.619
February	52.010	41.373	233.750	183.144
March	63.043	41.219	282.988	183.473
April	59.172	.....	267.136	.....
May	55.651	.....	250.645	.....
June	55.851	.....	249.852	.....
July	59.245	.....	263.540	.....
August	59.465	.....	264.595	.....
September	58.675	.....	258.943	.....
October	51.654	.....	223.869	.....
November	43.299	.....	190.477	.....
December	43.051	.....	190.449	.....
Year	54.337	.....	242.133	.....

New York quotations cents per pound. London, pounds sterling per long ton.

ZINC

	St. Louis		London			
	1937	1938	1937	1937	1938	1938
			Spot	3 Mos.	Spot	3 Mos.
January	5.847	5.000	21.153	21.281	14.994	15.173
February	6.465	4.813	25.122	25.322	14.408	14.589
March	7.381	4.417	33.188	33.405	14.364	14.477
April	7.010	.....	26.216	26.344	.....	.....
May	6.750	.....	23.092	23.365	.....	.....
June	6.750	.....	21.409	21.528	.....	.....
July	6.923	.....	22.568	22.693	.....	.....
August	7.192	.....	24.140	24.290	.....	.....
September	7.190	.....	21.406	21.607	.....	.....
October	6.085	.....	17.722	17.955	.....	.....
November	5.630	.....	15.808	15.970	.....	.....
December	5.010	.....	15.274	15.429	.....	.....
Year	6.519	.....	22.258	22.432	.....	.....

St. Louis quotations, Prime Western, cents per pound. London, pounds sterling per long ton.

CADMIUM AND ALUMINUM

	Cadmium		Aluminum	
	1937	1938	1937	1938
January	90.000	117.500	19.500	20.000
February	90.000	117.500	19.500	20.000
March	101.667	117.500	20.000	20.000
April	105.000	.....	20.000	.....
May	105.000	.....	20.000	.....
June	130.962	.....	20.000	.....
July	142.500	.....	20.000	.....
August	142.500	.....	20.000	.....
September	142.500	.....	20.000	.....
October	142.500	.....	20.000	.....
November	142.500	.....	20.000	.....
December	132.888	.....	20.000	.....
Year	122.335	.....	19.917	.....

Aluminum in cents per pound, 99 plus per cent grade. Cadmium, cents per pound.

ANTIMONY, QUICKSILVER, AND PLATINUM

	Antimony (a) New York		Quicksilver (b) New York		Platinum (c) New York	
	1937	1938	1937	1938	1937	1938
January	14.130	13.750	90.250	79.240	50.400	36.000
February	14.563	13.750	91.000	76.455	64.364	36.000
March	16.375	13.750	91.778	72.444	58.000	36.000
April	16.043	.....	92.000	.....	58.000	.....
May	14.830	.....	95.520	.....	54.800	.....
June	14.702	.....	96.654	.....	53.000	.....
July	14.803	.....	93.904	.....	50.115	.....
August	15.327	.....	91.423	.....	51.000	.....
September	16.555	.....	89.020	.....	51.000	.....
October	16.935	.....	86.140	.....	48.560	.....
November	15.848	.....	83.435	.....	43.652	.....
December	14.144	.....	81.038	.....	38.385	.....
Year	15.355	.....	90.180	.....	51.773	.....

(a) Antimony quotations in cents per pound, for ordinary brands. (b) Quicksilver in dollars per flask of 76 lb. (c) Platinum in dollars per ounce troy.

PIG IRON

	Bessemer		Basic		No. 2 Foundry	
	1937	1938	1937	1938	1937	1938
January	21.50	24.50	20.50	23.50	21.00	24.00
February	21.50	24.50	20.50	23.50	21.00	24.00
March	24.20	24.50	23.20	23.50	23.70	24.00
April	24.50	.....	23.50	.....	24.00	.....
May	24.50	.....	23.50	.....	24.00	.....
June	24.50	.....	23.50	.....	24.00	.....
July	24.50	.....	23.50	.....	24.00	.....
August	24.50	.....	23.50	.....	24.00	.....
September	24.50	.....	23.50	.....	24.00	.....
October	24.50	.....	23.50	.....	24.00	.....
November	24.50	.....	23.50	.....	24.00	.....
December	24.50	.....	23.50	.....	24.00	.....
Year	23.975	.....	22.975	.....	23.475	.....

Iron in dollars per long ton. F. o. b. Mahoning and Chenango Valley furnaces.

PERSONAL ITEMS

Ella Barnett photo, courtesy Grace Line

MR. AND MRS. WILLIAM J. TURNER

William J. Turner, general manager of the Braden Copper Company, accompanied by Mrs. Turner, left New York on March 17, on the Grace Liner "Santa Clara," en route for Chile. Braden, a subsidiary of Kennecott Copper Corporation, produced 318,169,808 lb. of copper in 1937.

Frank C. Bowman, consulting engineer of Denver, Colo., was in New York on professional business in the latter part of March.

W. P. Rodgers, mining engineer, of Charleroi, Pa., was a visitor in New York in March.

T. W. Bingay has been reelected president of the Mining Association of British Columbia.

Hugh G. MacLellan has been made deputy inspector of mines for the Province of Nova Scotia.

E. M. Lindenau is now acting as engineer for the Eagle-Picher Mining & Smelting Company, with headquarters at Tucson, Ariz.

J. R. Bovyer, mining engineer, until recently with Lodestar Mining Company, Mojave, Calif., has joined the staff of Arizona Comstock Corporation at Virginia City, Nev.

H. F. Harwood was recently awarded the Wollaston Fund by the Geological Society of London, "in recognition of his research work on the chemistry of minerals and rocks."

D. C. Deringer, mill superintendent at Patiño Mines & Enterprises Consolidated, Inc., Bolivia, recently arrived in the United States for an extensive vacation.

Thomas S. Bailey, identified for a number of years with the mining industry in Colorado, is now mill superintendent for the Cornucopia Gold Mines Company, of Cornucopia, Oregon.

Lucien Eaton, of the staff of the Copper Range Company and Isle Royale Copper Company, was in New York late in March.

Murray N. Coleman, metallurgical engineer, who is in charge of the tailings re-treatment plant of Kennedy Mining & Milling Company at Jackson, Calif., has moved his office from 206 Sansome St., to 1414 Mills Tower Building, San Francisco.

Clark J. Parker, formerly with the San Francisco Mines of Mexico, Ltd., in the capacity of experimental metallurgist, is now with the Potash Company of America at Carlsbad, N. M.

E. A. Collins, assistant to the general manager of the International Nickel Company, was on March 17 elected president of the Canadian Institute of Mining and Metallurgy for 1938 by fellow members of the Institute in session in Toronto at their 39th annual meeting. The new president succeeds the **Hon. Michael Dwyer,** Minister of Lands and Mines for Nova Scotia. Mr. Collins was graduated

E. A. COLLINS

from Queens University in 1905. After some years of interesting experiences in mining and prospecting he joined the staff of International Nickel in 1918, and two years later was promoted to his present position. It was largely through his offices that the company awarded its "Inco" medal, administered by the Canadian Institute and conferred each year as a mark of distinction to a person who has made a meritorious and practical contribution of outstanding importance to the mineral industry. Mr. Collins was also the founder of the award for bravery —the Victoria Cross of the Institute.

H. L. Heath, formerly in charge of mines in Eldorado County, Calif., is manager for the Esmeralda Gold Mines, Ltd., operating a mill in the Gold Circle district in Elko County, Nev.

W. R. Wright passed through New York on April 4 returning to British Guiana, where he has been prospecting for Messrs. Booker Brothers, McConnell & Company, Ltd., of British Guiana.

John S. Bagg, who has been engaged in reopening long-idle silver-lead mines at Hamilton, is operating also the Silver Connor mine, on Prospect Mountain, near Eureka, Nev.

W. M. Morgan, who has been acting as field superintendent of Bendigo Mines, N. L., Bendigo, Vic., has accepted a position on the staff of Lake George Mines, Ltd., Captain's Flat, N.S.W.

Paul A. Lagerquist, sales engineer for Australia and New Zealand for the Gardner Denver Company, arrived in Australia at the end of January and is now on a visit to the mining fields.

A. K. Lindsay recently sailed from San Francisco for Colombia, where he is employed by Pato Consolidated Gold Dredging, Ltd., as a placer engineer. His address is Pato, Colombia, care of the company mentioned.

Col. Willard Chevalier, vice-president, McGraw-Hill Publishing Company, will deliver the Commencement address at the graduation exercises of the South Dakota School of Mines next June.

Andre M. Tweedt, mining geologist and engineer, formerly general manager of Allied Annie Laurie Gold Mines, Inc., at Sevier, Utah, has severed his connection with that organization. His present address is 660 Vernon St., Oakland, Calif.

Dr. Paul D. Merica, vice-president of the International Nickel Company of Canada, was presented with the John Fritz Medal, the highest honor in the engineering profession, at a din-

DR. PAUL DYER MERICA

ner given in celebration of his 49th birthday, at the Metropolitan Club, in New York City, on March 17 under the auspices of the A.I.M.E. Arthur S. Tuttle, chairman of the 1937 John Fritz Medal Award Board, made the presentation. Notice of the award of the medal to Dr. Merica appeared in the November, 1937, issue of *E.&M.J.* Dr. Merica shares with Marconi the

distinction of being the youngest to receive the award, which was made "in recognition of his contribution to the development of alloys for industrial uses."

Edward S. Kneeland recently arrived in New York City for an extensive vacation. Mr. Kneeland is employed by the Patiño Mines & Enterprises Consolidated, Inc., in Bolivia.

Mark Bradshaw, president-manager of the Bradshaw Syndicate, Inc., has returned to resume operation of his company's 1,500-ton tailing treatment plant at Goldfield after an airplane trip to New York.

Robert Lord, metallurgist for the Southwestern Engineering Company, has returned to headquarters in Los Angeles from Baja California, Mexico, where he supervised the tuning up of the new tungsten mill completed recently at the El Fenomena mine.

Juan Francisco Illades has resigned his position with Cia. Minera de la Mazata y Anexas, S. A., at Etzatlan, Jalisco, and is now working as safety and mining engineer with Cia. Minera de Guadalupe, S. A., at Pregrina, Guanajuato.

W. I. Nelson recently resigned as superintendent of the Mother Lode Central Mines, at Angels Camp, Calif., to take the position of general superintendent of operations of the Granby Consolidated Mining, Smelting & Power Company at Copper Mountain and Allenby, B. C.

H. B. Hanson was appointed general superintendent for the San Francisco Mines of Mexico, Ltd., on Jan. 1, 1938, prior to which date he had been general superintendent of Cia. International Minera, S. A. Both companies are subsidiaries of Union Corporation, Ltd., of London.

George H. Cunningham, consulting engineer, is engaged on work for the Cerro de Pasco Copper Corporation, 44 Wall St., New York City. He is at present visiting the company's properties in Peru, South America.

Wallace V. Peck is now with the Tintic Standard Mining Company, in the company's engineering department. He alternates his time between the Eureka Standard and Tintic Standard, the engineering staff serving both mines, which are in the Tintic district of Utah.

M. E. Playford, chief metallurgist of Wiluna Gold Mines, Ltd., is joining Mount Morgan, Ltd., as assistant general manager. Prior to going to Wiluna Mr. Playford was, in succession, mill superintendent at Mount Lyell, Tasmania, and assistant general manager of Great Boulder Proprietary, Kalgoorlie, W. A.

Sir Herbert Gepp, Melbourne, Australia, is visiting the United States and Canada, observing economic and business conditions. Formerly identified with the zinc industry of Broken Hill and Tasmania, Sir Herbert is now devoting himself to public service. He is chairman and director of the aerial, geological, and geophysical survey of Northern Australia.

George I. Barnett, until recently in charge of quartz mining for Hammon Engineering Company, of San Francisco, has been appointed general superintendent of Cactus mine, Cactus Mining Company, Rosamond, Calif., the home office of which company is 1210 Pacific Mutual Building, Los Angeles.

H. C. Enos, general manager of Lane-Rincon Mines, Inc., operating in the State of Mexico, Mexico, after three months of negotiations has signed the new collective labor contract with the Miners Syndicate. Several times during negotiations the miners were on the point of striking, but the differences were finally settled.

Capt. A. C. Reade recently returned to Oregon from British Columbia, and is operating with **W. B. Grant** and **F. J. Pike** on the Golden Princess Placers, Josephine Creek, at Kerby, in Josephine County, that State. A wet winter assures a long run this season, and efforts are being made to establish definite savings of metals of the platinum family that exist on the property. Though the district has long been known as an excellent free-gold country, there has been a continual loss of platinum and osmiridium values. Experimentation is now being undertaken to correct this condition.

▼ ▼ ▼

OBITUARY

Arthur Winslow, a mining engineer formerly active in gold and silver mining, died in Boston, Mass., on March 28, at the age of 77.

Winthrop C. Neilson, a vice-president of the Aluminum Company of America, died at his Ardmore, Pa., home on

WINTHROP C. NEILSON

March 12. He was 60 years old. Mr. Neilson had held his present office since 1931, but was concurrently president of the Republic Mining & Manufacturing Company. Born in Philadelphia, he attended the University of Pennsylvania, from which he was graduated in 1899. He was a member of the American Institute of Mining and Metallurgical Engineers and of many clubs.

G. Roscoe Fertich, commissioner of the War Minerals Relief Commission, died on March 11 at the age of 52.

Samuel William George, consultant and manager of mines, died recently in London at the age of 46.

William Kennedy McNeill, provincial assayer for the Ontario Department of Mines since 1917, died recently at the age of 57.

George A. O'Brien, inspector of Mines for Vancouver, Island, and formerly manager of Wellington mine, in the Ainsworth division of British Columbia, died recently, aged 62.

Eric Newbold, general manager of the Eastern Smelting Company, which has smelting properties in Panang, Straits Settlements, was killed recently in an airplane accident at Panang.

A. D. Sligo, representative of O. T. Lempriere & Company, ore buyers, at Zeehan, Tas., and for many years a prominent figure in the development of the Zeehan and near-by districts, died recently at the age of 71 years.

Adrien-Gaston Calley Saint Paul de Sincay, administrator-director general of the Société Anonyme des Mines et Fonderies de Zinc de la Vielle-Montagne, Chenee, Belgium, died on March 19 in Brussels at the age of 84.

Arthur Douglas Lumb, since 1919 mining adviser to the African & Eastern Trading Corporation, and latterly with the United Africa Company, died on Feb. 4. He was a member of the Institute of Mining and Metallurgy and a Fellow of the Geological Society of London.

John D. Fisher, 60, who was active for years in the Park City district of Utah, died at his home in Salt Lake City on March 9. Mr. Fisher was born at Heber City, Utah, and educated in the schools there and at Park City, where his father was superintendent of the Ontario mine. Mr. Fisher had directed activities at the Naildriver, the Star of Utah, and other Park City mines.

Charles Muffat, a pioneer in the mining industry of Colorado and Mexico, died in Detroit, Mich., on Jan. 9, 1938, aged 78. He went to Sierra Mojada, Mexico, in 1889, and was later with the American Smelting & Refining Company at Parral, Chihuahua, in which State he continued to hold mining interests to the time of his death. He is survived by his widow and two brothers.

W. Clayton Miller, 78, pioneer mining engineer of the West, died in Los Angeles the week of March 3. Mr. Miller played an important part in the mining history of the Coeur d'Alenes, assisting in the preliminary negotiations leading to the forming of the Federal Mining & Smelting Company. Mr. Miller became general manager of the Federal after being in charge of the famous Last Chance mine, in Wardner. He compiled one of the earliest authentic maps of the Coeur d'Alene mining area in 1899.

What Metal Statistics Show

ACTIVITY in the mining industry during the first quarter of the year was centered among gold and silver producers. Output of base metals, however, continued on a restricted basis, and as the industry views the second quarter, many believe further curtailment will become effective as the weather moderates. Observers think that the deferment of this Government's policy to purchase silver from Mexico will have no influence on the domestic price structure even though the foreign price has lowered and was quoted here at 42⅜c. per oz. on March 31.

The February statistics of the Copper Institute showed that the domestic situation continues out of balance, stocks of refined metal increasing by 27,111 tons. Abroad, however, stocks decreased 3,227 tons. Mine production and custom intake for February in this country dropped to 51,062 tons, which compares with 58,760 tons in January and the peak for last year of 94,596 tons in April. Production for February was 46 per cent below the monthly high of 1937. Further curtailment is being put through at various properties, and, unless consumption improves appreciably in the near future, mine operations this summer will probably be cut to the bone.

The statistics of the copper industry, covering January and February, are summarized as follows, in short tons:

	Jan.	Feb.
Production (blister):		
U. S. mine	49,600	43,310
U. S. scrap, etc.	9,160	7,752
Foreign mine	95,939	89,869
Foreign scrap, etc.	12,682	12,215
Totals	167,381	153,146
Production refined:		
United States	70,487	59,393
Foreign	103,815	101,957
Totals	174,302	161,350
Deliveries to customers:		
Domestic	24,881	27,389
Foreign	114,647	110,077
Totals	139,528	137,466
U. S. exports of domestic copper	5,824	4,893
Stocks, refined:		
United States	299,133	326,244
Foreign	206,836	203,609
Totals	505,969	529,853

Following is a record of sales of copper in the domestic market, by months, for 1936, 1937 and the first three months of the current year, in short tons:

	1936	1937	1938
January	33,165	53,819	25,543
February	78,654	74,912	23,518
March	35,948	53,101	22,012
April	158,064	26,143	.....
May	16,303	43,130	.....
June	16,521	35,395	.....
July	175,484	62,298	.....
August	25,253	69,225	.....
September	40,769	28,936	.....
October	178,801	23,238	.....
November	88,177	21,035	.....
December	117,715	26,504	.....
Totals	964,854	517,736	.....

The industry generally believes actual consumption of copper since January has been larger than indicated by deliveries, which were 24,881 tons in January and 27,389 tons in February. Estimates for March lie above 30,000 tons, but new freight rates that went into effect March 28 influenced consumers to move their metal into their plants, thereby avoiding paying the higher freight rate. The industry places actual consumption for January at 32,000 tons, February 37,000 tons, and about 40,000 tons for March. Therefore, actual copper has been disappearing from most consumers' stocks, and producers believe buying on a larger scale for replenishing will appear during the second quarter, now beginning. The domestic refined stocks, however, totaling 326,244 tons at the end of February, compared to 136,121 tons a year ago, are considered more than ample to supply consumers' requirements even if there should be a modest improvement in the present business level. During the latter part of March fabricators of wire reported a seasonal improvement, but other consuming lines showed little change. Foreign business was brisk all during March. This has been an important factor in supporting the domestic price at the 10c. level.

▶ LEAD—Production of lead during March continued on the curtailed basis, and consumption of metal is believed to have continued on a scale comparable to the first two months of the year. Ship-

The refined-lead statistics for February showed another moderate increase in stocks, the supply on hand at the end of the month amounting to 138,134 tons, a gain of 4,733 tons.

The refined-lead stitistics for January and February, in short tons, according to the American Bureau of Metal Statistics:

	Jan.	Feb.
Stock at beginning	129,131	133,401
Production:		
Domestic ore	37,651	33,555
Secondary and foreign	1,545	1,314
Totals	39,196	34,869
Domestic shipments	34,923	30,135
Stock at end	133,401	138,134

Shipments to consumers dropped to 30,135 tons for February, which compares with 34,923 tons in January, and 50,375 tons in February last year. Production in February was 34,869 tons, or 4,327 tons less than in the month previous.

▶ ZINC—Unsettlement has prevailed in the zinc industry during the last month, resulting from lower prices for metal ore and concentrate. Stocks of common grades of zinc increased 9,871 tons in March, total stocks now being 118,009 tons. Shipments were higher, totaling 33,528 tons, compared to 21,540 tons in February, but the industry believes new freight rates that became effective on March 28 chiefly responsible for the increase. Gains in consumption in some directions have been reported, but on the whole these have been below expectations.

The February and March statistics of the American Zinc Institute, covering all grades, are summarized as follows, in short tons:

	Feb.	March
Production	41,146	43,399
Production, daily rate	1,470	1,400
Shipments	21,540	33,528
Stock at end	108,138	118,009
Unfilled orders	38,891	29,023

The Prime Western division of the zinc industry reports as follows for February and March on the common grades:

	Feb.	March
Stock at beginning	40,699	48,231
Production	21,755	22,404
Shipments	14,223	21,634
Stock at end	48,231	49,001

Production of Flotation Concentrates, Mexico

(Quantities in Tons of 2,000 Lb.)
American Bureau of Metal Statistics

	Lead			Zinc			
Year	Total	Lead Content	Per Cent	Total	Zinc Content	Per Cent	Lead Content	Per Cent
1929	270,436	137,947	51.01	309,061	163,145	52.78	4,959	1.60
1930	294,543	149,587	50.79	280,604	147,776	52.66	5,349	1.91
1931	272,341	153,096	56.21	265,434	140,235	52.83	2,333	0.88
1932	171,003	100,542	56.80	144,012	76,281	52.97	1,482	1.03
1933	183,510	105,668	57.58	164,535	88,106	53.55	1,405	0.85
1934	251,556	139,040	55.42	275,295	145,751	52.94	1,791	0.65
1935	287,384	145,258	50.54	284,414	149,119	52.43	1,550	0.54
1936	320,379	151,107	47.17	288,191	150,779	52.32	2,392	0.83
1937	330,783	158,600	47.95	342,998	180,718	52.69	3,823	1.11

The above statistics are based on practically complete returns from all the mills. They are substantially representative of the total production of zinc ore in the country. A good deal of Mexican lead ore is obtained otherwise than from the flotation process, and consequently the totals of the above table fall materially short of accounting for the lead production of Mexico.

Cinco-Mineros Dredge Company operates this gold dredge in Honcut Creek, near Palermo, Calif. About 2,000 cu.yd. of gravel is washed per day. Power on the dredge and dragline is provided by two Caterpillar diesel engines

CALIFORNIA

Lower Rates for Mining Compensation Insurance

Cost of underground protection reduced 77c. per $100—Some damage suffered by mines in recent storms and floods

▶ Effective April 1, mining compensation insurance rates will be substantially reduced, according to a letter from Samuel L. Carpenter, Jr., Insurance Commissioner, to Claude M. Chaplin, general manager of the Mining Association of California. Under the new ruling, underground mining rates will be reduced from $9.44 per $100 of payroll to $8.67; surface mining from $7.72 to $6.35; and surface employees from $7.72 to $5.43. On Feb. 3 Mr. Chaplin wrote the Insurance Commissioner declaring that actual accident experience warranted a rate of about $7 for underground mining and $5 for surface mining (*E.&M.J.*, March issue).

▶ A milling plant to handle company ore as well as custom ores is to be installed at the Omar mine, near Auburn, Placer County, now operated by Ophir Nevada Mining & Milling Company, A. Schneider, president. Reconditioning of the mine is practically completed, and a vein of good ore is being developed and prepared for production.

▶ Under the management of J. F. and Glen De La Mare and A. A. Haight, the Black Hawk mine, at Randsburg, is again producing. Improvements made recently include installation of an electric motor for the compressor, pipe and rail, and timbering of the stope on the 450-ft. level, where a vein of good ore has been found.

▶ The Squirrel Creek placers near Johnsville, Plumas County, are reported to have been taken under lease by W. K. Yorston, Nevada mine operator, who plans operations in the spring.

▶ In the Seneca mining district, Plumas County, Shaffer Gold Mines is reconditioning the White Lily mine for early operation, with B. F. Barbee, superintendent, in charge. Of the gravel mines active, the property of the Glacier Mining Company is now being operated on a three-shift basis with about 80 to 100 tons of gravel washed at the mill every 8 hours. At the Dutch Hill mine, E. M. Savercool, general manager, general development work is in progress pending actual production in the spring, and exploration and development work is carried on at the Sunnyside property, headed by H. Struckman.

▶ Contrary to general reports, mining properties throughout the State have suffered relatively little damage during the recent storms and floods. Save for brief shutdowns because of interrupted electric power service, and destruction of several small surface plant buildings either by washouts or earth slides, no major damage has been reported from the different mining districts.

ARIZONA

Development Planned For Vanadium Mine

Construction program under way by International Vanadium Corporation of Arizona—Small gold producers spur their development

▶ Plans for an extensive development program by the International Vanadium Corporation, 28 miles southeast of Globe, are announced by Dr. P. F. DeVilliers, South African authority on vanadium, who is in charge of the work. Equipment for a new process in ore treatment is being installed. A force of 26 men is now employed and former plant capacity of 100 tons will, according to report, be more than doubled when the work is completed. The improvements provide for water reserve, larger power plant, construction of buildings, and installation of other machinery.

▶ The Gold Dike Mining Company, with headquarters at Prescott, will commence operation of the company's properties in Lonesome valley between Prescott and Jerome. Howard H. Field and T. J. Byrne, both of Prescott, are in charge.

▶ Emsco Asbestos Company is developing some properties about 60 miles northeast of Globe. It is reported the company has a fiberizing plant of 600 tons' monthly capacity at Downey, Calif.

▶ Gold Bond Mining Company has sold to J. W. Thompkins, of Phoenix, property situated in the Superstitious Mountains. The mine was first opened in 1872 and is one of the historic properties of that section.

▶ Catoctin mine, near Prescott, which has been working under lease for the last eighteen months, is to have a mill and other equipment soon, according to J. C. Meikle and associates. New ore has been developed in the old workings and new shoots have been found in the course of development. The ore carries gold, silver, lead, and copper.

▶ Greenfield and McSpadden, of Los Angeles, have taken a lease on the Townsend Mining Company's properties in the Bill William River country in Yuma County. A mill is planned for the treatment of the gold ores from these claims as well as from other mining properties which they own in that area.

▶ Glenville A. Collins, mining man of San Francisco, and president of the Sunbeam Gold Mining Company, is preparing to open up the Roadside mine, in the Katherine district, Mohave County, 40 miles west of Kingman. This property formerly shipped ore to the mill of the Gold Standard company at Katherine.

▶ The Pack Rat mine has installed a new compressor and other equipment on the copper property owned by Charles Lockridge and Samuel Zarberry. This is the only producing mine in northern Coconino County. It is situated about 20 miles north of Williams. The ore is hauled 110 miles to the smelter at Clarkdale.

▶ Johnson Gold Mines, Inc., of Octave, T. A. Barkley, superintendent, reports additional ore reserves being found. The property is equipped with a 60-ton flotation-amalgamation plant. Ralph Roseberry, 124 West Fourth St., Los Angeles, is president and general manager.

▶ Hope Metals Company, near Winkelman, is driving a 400-ft. raise to cut known orebodies shown above the tunnel level. Operations are being directed by Arthur C. W. Bowen.

▶ Santa Maria Ventures Company is installing new equipment at the Turn-

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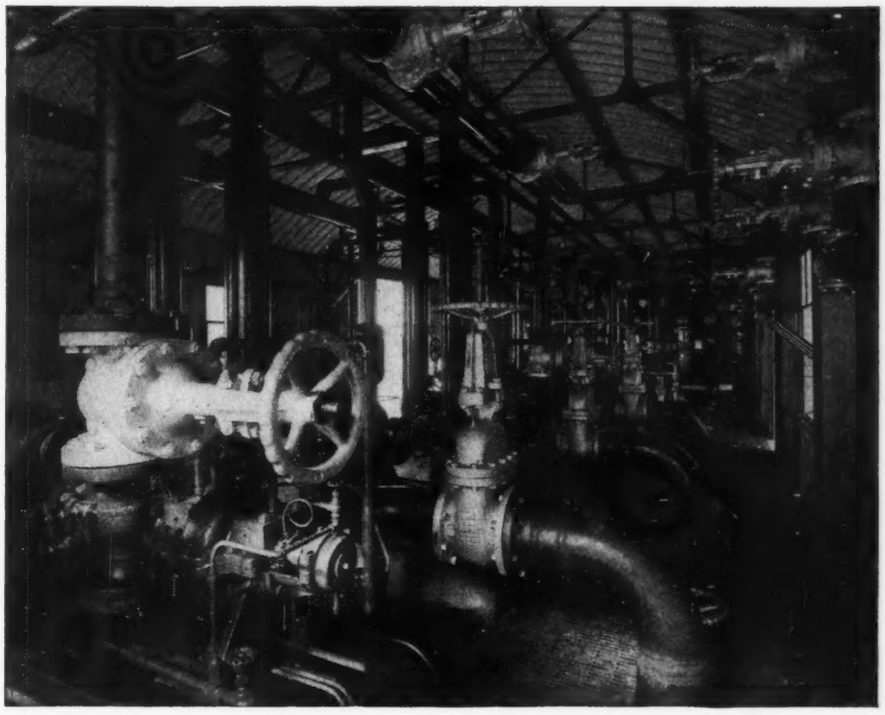

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▶ARIZONA

bough mine, on the Santa Maria River, 30 miles west of Hillside. The mine is shipping about a carload of ore a week. Joe Carson is mine superintendent.

▶ Mocking Bird mine, 20 miles northwest of Chloride, is running its mill steadily, treating ore mined from a blanket vein containing copper and gold. A shortage of water for mill purposes is handicapping production of concentrates, but water development is under way and the situation is soon expected to be relieved.

▶ The new leaching plant being installed by the Vivian Mining Company near Oatman, in Mohave County, is about ready for operation. A. E. Dirrim, manager of the company, reports having taken over the Del Rey mines, near the Vivian. Ores from this property will be treated at the Vivian mill.

▶ The installation of the cyanide tanks is completed at the Pioneer mill, operated by Producers, Inc., and first runs are being made. The first runs are on dump ore, which will be followed by mine ore as quickly as crushing equipment is installed. Robert Elgin, of Chloride, is general manager.

▶ J. M. Beach, of Los Angeles, acting as agent, has taken over the Gold Bar mine, at Constellation, and will unwater it. According to old reports the mine has a record of $150,000 production. Sufficient ore is said to be blocked out to start production soon.

▶ Ted Farley and J. T. Conger, of Los Angeles, have taken over the Diamond Joe and Ezperanza properties, in the Cedar district of the Hualapai Mountains south of Kingman, following a recent examination. Both of these mines were operated years ago when only high-grade ores could be produced profitably.

UTAH

Salt Lake City Gets $300,000 Mines Station

Building will be located on University campus—Mining companies' reports show good earnings in 1937

▶ The location of the long-awaited intermountain Bureau of Mines station at Salt Lake City will be on the University of Utah campus on a five-acre tract northeast of the present mines station building. This was decided at a conference held recently by President George Thomas of the University of Utah and Dr. R. S. Dean, chief engineer of the metallurgical division of the United States Bureau of Mines. Congress recently passed an act providing that a $300,000 mines station be established at Salt Lake City.

▶ The Utah Copper Company won a refund of $80,982 in taxes, paid under protest to Salt Lake County for the year 1934, when the United States Supreme Court at Washington, D. C., refused to review a decision of the Tenth Circuit Court of Appeals awarding the judgment to the company. This decision settles the point that in determining the copper company's net proceeds only the copper produced during the tax year can be taken into consideration. The State Tax Commission and Salt Lake County had contended net proceeds should also include the copper produced in other years and held over and sold.

▶ Net income of the Tintic Standard Mining Company and its subsidiaries, including the Eureka Standard mine, increased 38 per cent during 1937 to $961,653.81 as compared with a net income of $697,955.44 in 1936. This statement was made in the company's annual report by James W. Wade, Walker Bank Building, Salt Lake City, vice-president and general manager. The greater part of the output came from the Tintic Standard mine. Gross proceeds from the Tintic Standard amounted to $2,697,117.26 and the Eureka Standard, $1,083,999.85.

▶ Silver King Coalition Mines Company shaft in Thaynes Canyon has reached a depth of about 500 ft. Stations have been cut at two levels. Three shifts are being employed. The company produced during 1937 a total of 141,280 tons of ore, valued after railroad and smelter charges at $3,345,416.65. After depreciation, a distributable profit of $1,486,269.70 was left; $195,525.17 was added to surplus, and $1 a share paid in dividends.

▶ Ore values of the Park City Consolidated Mines show a steady improvement as depth is gained, according to the report of General Manager Gloyd M. Wiles, Park City. A recent development was the opening of ore on the 1,160 level in the East Crescent fissure, which, Mr. Wiles reports, assays 22 oz. of silver to the ton, 8 per cent lead, and 5 per cent zinc.

▶ The Utah Ophir Mines Company is drifting on a northeast fissure at a point about 110 ft. from the collar of the incline. Shipment of 392 tons of ore during 1937 brought net returns of $6,841.19, or $17.45 a ton, according to the report of Manager J. F. Featherstone, Newhouse Building, Salt Lake City.

▶ Tintic Western Mining Company has resumed sinking of its shaft at a depth of 265 ft., 14 miles west of Eureka, in the West Tintic district. Drifting on the 300 level will be done to explore the Orient vein. Work is being done by Joe Corac and Antone Ferkovitch.

▶ Reports from the Grand Deposit Consolidated Mines, northeast of Ely, stated that a high-grade showing of ore has been struck on the 200-ft. level west of the shaft. Samples, according to Manager Paul C. Lyons, Atlas Building, Salt Lake City, assay 0.36 oz. gold, 37 oz. of silver, and 18 per cent lead to the ton.

▶ Paul and Nick Kolovos, leasers, have opened a full face of shipping ore in the upper levels of the Cardiff mine, South Fork of Big Cottonwood Canyon, near Alta. The ore is a high-grade carbonate, similar to that which produced so heavily in the Cardiff and the adjoining Columbus-Rexall. The new strike is situated in the Boundary Stope area above the Cardiff 500 level and the Columbus-Rexall No. 12 area. The lease embraces ground in both properties.

COLORADO

New Mill Planned at Cimarron Mine

Property is one that may benefit by recent find of deep-ore horizon in Smuggler Union—Iron-ore shipments begin from Wyoming to Colorado Fuel & Iron plant in Pueblo

▶ The Amparo Mining Company, of Philadelphia, is now making preparations to construct a new mill at the Cimarron property, at Telluride, this spring. The Smuggler Union, adjoining the Cimarron, recently sunk a shaft 335 ft. deep and found ore running up to $40 per ton. The company also has considerable dump ore that may be treated in the new plant. E. R. Gordon is engineer in charge of operations at Durango.

▶ Activity has been at the peak about the Black Bear, Cimarron, Japan Flora, and Liberty Bell mines, at Telluride, and the Camp Bird, Revenue, and Atlas mines, at Ouray (in this same mining section) since the discovery of rich ore at the La Veta mines. The new vein is opened on the 16th level; stations and pockets have been completed on the 17th level. The shaft has three compartments employing 2- and 3-ton skips, and hoisting capacity is 400 tons per 8 hours. Two new centrifugal pumps with a capacity of 1,000 g.p.m. against a 250-ft. head have been installed; mucking machines and a Mancha electric locomotive have been placed in operation. Robert Sayre, general manager, and John Ferguson, mill superintendent, expect to enlarge the capacity of the mill this spring and add new machinery. Charles Glasgow is general superintendent.

▶ Due to the reopening of the rail mill of the Colorado Fuel & Iron Company plant at Pueblo, the Sunrise mines, at Sunrise, Wyo., have started operations and will probably ship 60 or more cars of iron ore per day to the Minnequa plant.

▶ The financial sheets for the larger producers in Colorado for 1937 show an interesting increase in profits. Golden Cycle Corporation, of Colorado Springs, treated 510,612 tons of ore with total value of $5,585,605. Of the total tonnage, 475,967 tons was received from the Cripple Creek district, which had an average value of $10.61 per ton. The remaining 34,645 tons treated was from other mining districts, and showed an average of $15.42 per ton. Operating expenses for the year averaged $2.03 per ton. The higher cost of operations

WHY Exide-Ironclads are the most widely used batteries for underground haulage

WITH a few isolated exceptions, there is no tougher form of battery service than underground haulage. Getting ore out of a mine or material out of a tunnel takes power, as well as stamina and endurance in *all* the equipment. Haulage must be speedy, uninterrupted, and *definitely dependable.*

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▶COLORADO

was in a great measure due to higher wages, which were the highest in the history of the mill. The New Jersey Zinc Company, parent company of the Empire Zinc Company, with larger operations at Gilman, Colo., showed a marked improvement over 1936 operations, the average of $4.01 being comparable with $2.67 per share over the company's entire operations in the United States.

▶ The United States Vanadium Corporation, a subsidiary of the Union Carbide Company, operating at Uravan, Colo., is now employing some 260 men, and producing, through the mill, an average of one ton per man per day. This company owns its own coal mine and salt mine, and is nearly free from the extreme winters in the southwestern part of Colorado. Mr. Burwell is general manager.

▶ H. A. Walstrom and associates, working on the Montana, above Blackhawk, are preparing to open the old Farr mill, as they are ready for steady production. The mill was operated formerly by Mr. Farr, of Greeley.

▶ The main activity the past couple of years along the London Fault has been centered about the South London mine, the London Butte mine, and the Fairplay Mines Company. The principal producer, London Gold Mines Company, under the direction of H. L. Tedrow, has operated steadily, putting over 200 tons per day through the mill. The London Butte Company, across the gulch from the London Mines Company, has averaged over 1800 tons per day, during the past year, and is now engaged in extensive development work. And in North Mosquito Gulch, also on the London Fault, Fairplay Mines, Inc., under J. Price Briscoe, milled an average of a hundred tons daily for several years, until the property reverted to the London Mines Company last November. In addition to these operating properties there are extensive placer workings about Alma.

▶ Gold Coin Mining Company, under the direction of William Fisher, of Denver, is planning to complete the new cyanide mill on the property of the Gold Coin No. 1, near Pitkin, for spring operations.

MONTANA

New Dragline Unit on Grasshopper Creek

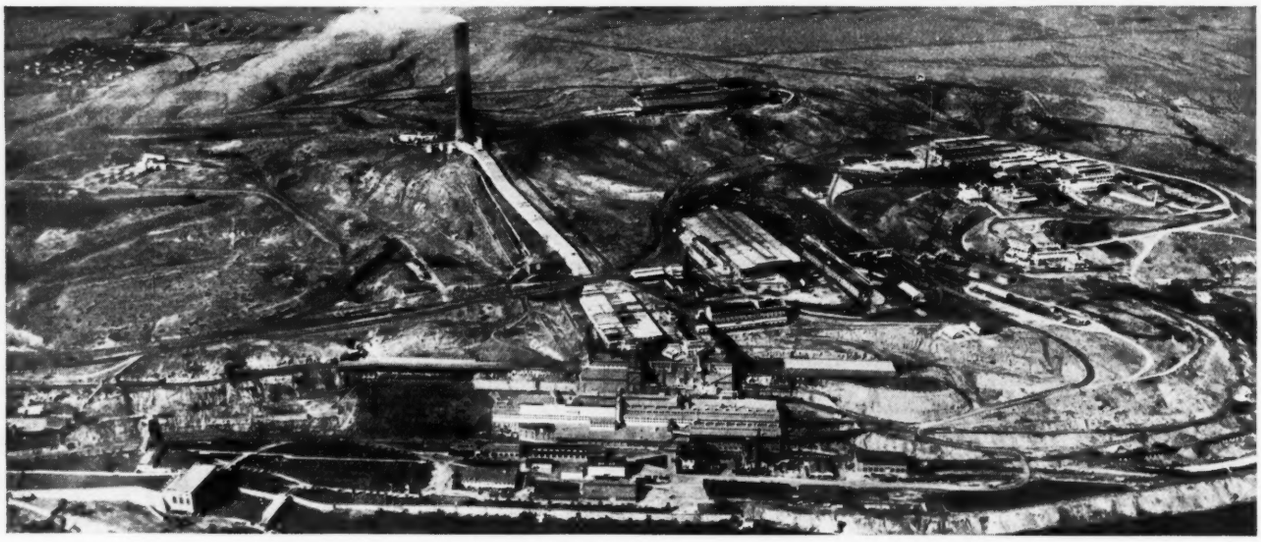
Placer area is tested by drilling—Gold strike made in Tobacco Root Mountain region

▶ Installation of machinery is well under way at the placer property held by the Ralph E. Davis, Inc., of New York, on Grasshopper Creek, in Beaverhead County. A large electrically driven dragline plant built by the Bucyrus Company has been assembled. Excavation of the pit will be started at once prior to the assembly of the washing plant, which it is understood will be mounted on tracks in the bottom of the pit. Decision to undertake the operation was not made until an extensive preliminary test was completed, in which about 400 test holes were drilled. D. W. Meyer is general manager.

▶ An interesting strike was made recently in the Tobacco Root Mountain area about 7 miles east of Twin Bridges, on the Highland Fraction claim. Since that time many new locations have been made in the district. The strike is described as a strong high-grade gold vein from which trial shipments were made by the owner, Alfred Ellis, of Twin Bridges. According to latest reports, Mr. Ellis has sold his interest to J. C. Roberts, of Spokane, who has already moved some machinery to the property. Near-by patented ownership claims are held by the Elling estates, of Virginia City, and the Largey estate, of Butte; and a group is held by Turk and Rudman, of Butte. The ore vein where discovered is reported to be several feet wide and to contain a good gold content.

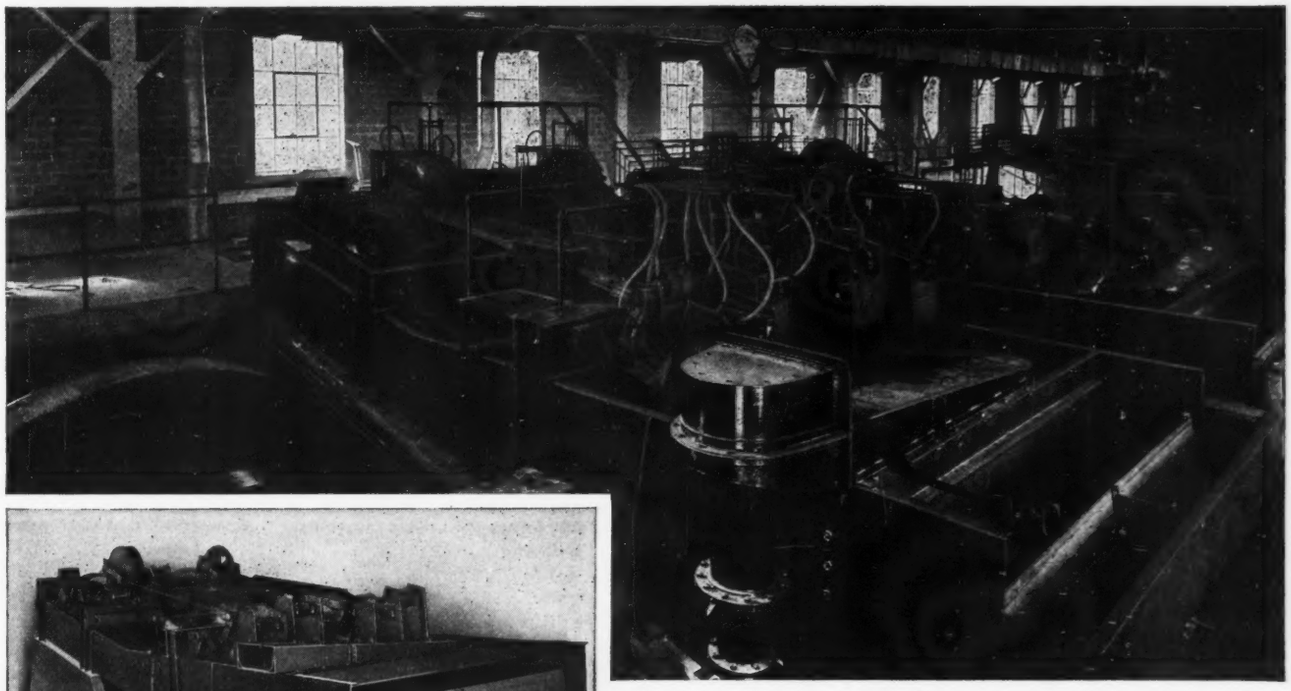
▶ Operations throughout the winter have been continued at the Jardine mine of the Jardine Mining Company, near Gardner, Mont., under the management of L. E. Riter. The property was recently visited by Mr. Hax, president of the company, from New York. At present about 80 men are employed at this gold producing property.

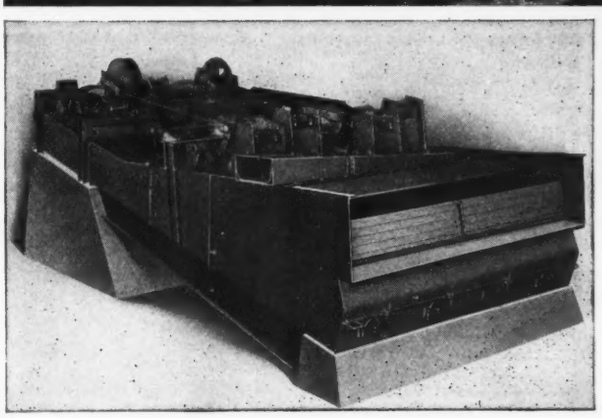
▶ The Mining Association of Montana held a meeting on March 17 at Butte, at which Chester T. Lane, of the Washington, D. C., office of the Securities Exchange Commission, and Day Karr, regional administrator of the SEC, spoke on the problems of mine financing.



A recent aërial view of the Great Falls Reduction plant of the Anaconda Copper Mining Company in Great Falls, Mont. The Missouri River and the 25,000-h.p. hydro-electric plant of the Montana Power Company are in the foreground. Shops, general offices, and zinc-washing plant occupy buildings also in the foreground. The flat building in the center is the electrolytic copper refinery, which has a capacity of 27,000,000 lb. per month. Buildings to the right constitute the electrolytic zinc plant, having a capacity of 20,000,000 lb. of zinc per month. The rod and wire mill of the Anaconda Wire & Cable Company lies to the right of the stack

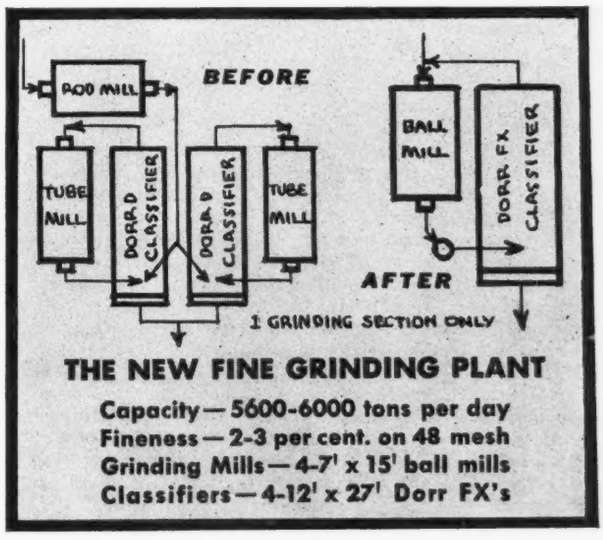
FINE GRINDING AND CLASSIFICATION





Above: The Hollinger's new fine grinding and classification plant.

Insert: A 12' Dorr FX Classifier, similar to the four installed at the Hollinger.



AT THE HOLLINGER

THE Hollinger's new fine grinding plant is generally regarded as being one of the finest and most modern in the entire mining world. Several years of study by Hollinger Engineers determined the facts on which this modernization program was passed.

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NEWS FROM Washington

By Special Correspondent

MINERAL INDUSTRIES are today more involved in international questions than ever before. Domestic policies of production and all of the problems of marketing are affected by many decisions of other governments or dictators who head foreign states. Official Washington is beginning to discover this, and may even give appropriate weight to this fact in legislation and executive administration which nominally affect United States affairs only.

Whether the State Department in its tariff making, Congress in its tax levies, and other agencies of Washington in their respective fields give the mining industry the benefit of the doubt will depend a great deal, it seems, on the attitude of industrial leaders. As one official put it, provincially minded mining executives are likely to get narrow consideration of their own requests. The critical implication was intended, that many mine enterprises are managed by men of limited outlook. But this implied criticism was evidently tempered by the desire to give friendly advice to mine executives generally, asking them to study world problems first before asking for Washington action regarding their United States troubles.

A Pro-Business Congress

MEMBERS OF CONGRESS are increasingly inclined to temper all legislation in accordance with the effect on business. For political reasons many are not at liberty to admit this, but their votes prove it. And the plans for the remainder of this session can be appraised accordingly. Everyone knows that the sure-to-pass list is now rather short, including principally the appropriation bills, the Government reorganization measure, special appropriations for a big Navy and other defense needs, and some kind of a tax bill.

A number of other measures of controversial sort will pass, but the final form enacted is likely to be far different than the original proposals, especially in such cases as wage and hour standards. The T.V.A. mess has blocked the original regional planning bill (7 T.V.A.'s) for this year. And anti-monopoly enactments are extremely unlikely. The fear of business jitters will prevent most Congressmen voting for these measures. It is much better to have no vote than to vote "No." So most of them will die in committee.

A great many officials in the career bureaus feel much as the Congressmen do, and are being very conservative in their public statements and cautious in administrative decisions. Even the President has tempered his remarks and his methods on a number of occasions. But at intervals he breaks out as in his Georgia address demanding higher wage levels in the South. But that particular address was probably barbed mainly to hurt Georgia politicians who have been unwilling to go along with the reform efforts of the Chief Executive. Presumably the President would have been glad if only Georgian ears could have heard it. He hopes votes down there will be against these "disloyal" Democrats. But he does not want to disturb the voters too much in those other jurisdictions where loyal New Dealers come up in primaries and Congressional elections later in the year.

These matters have large partisan political meaning. But they also affect business, including mining. The political significance must be understood in order to appraise the equally important industry implications.

U. S. DEFERS BUYING OF MEXICAN SILVER

EXECUTIVES of foreign mining companies in Mexico had occasion to ponder nervously about the Ides of March, and certain foreboding shadows that darkened the night of March 18 when President Cardenas of Mexico announced over the radio from Mexico City that foreign owned oil properties would be expropriated on the following day.

SEVERAL DAYS LATER from this side of the Rio Grande came a statement on March 27 by Henry Morgenthau, Jr., Secretary of the Treasury, that further obscured the troubled outlook of silver producers in Mexico and weakened the Mexican peso. The official announcement was:

"In view of the decision of the Government of the United States to re-examine certain of its financial and commercial relationships with Mexico, the Treasury will defer continuation of the monthly silver purchase arrangement with Mexico until further notice."

SINCE THE FIRST of this year the Treasury has absorbed 5,000,000 oz. of Mexican silver monthly in addition to an agreement reached last year under which the Treasury would acquire 35,000,000 oz. out of the reserve of the National Bank of Mexico. How long the Treasury will defer its silver purchases from Mexico after April 1 may depend upon how effectively President Cardenas restores confidence among the country's industry and business and regains control of the unstable financial structure.

ON MARCH 28 the silver market broke from 44¾c. to 43¾c., and dropped another cent on the following day, to 42¾c. The domestic price for newly mined silver at 64.64c. has not been influenced, however, by this action toward Mexico.

The T.V.A. Fracas

MINERAL INDUSTRIES in, or affected by, Tennessee Valley affairs will not be largely changed as a consequence of the unsavory T.V.A. episode. The Authority had not yet got deep enough into any mineral projects to make the slowing down now expected of more than passing interest. Therefore, the charges and countercharges on which the President acted to remove A. E. Morgan from the chairmanship can be appraised by mining executives most usefully from the standpoint of power policy and Presidential plans.

Nothing that has been brought out into the open in Washington during March seems to indicate that the President or Congress will greatly change the nominal plan for T.V.A. as the yardstick of public utility power costs. The gain of actual control of utility facilities in the South will, however, be slightly delayed. But the final result will not be very different at the end of the full Roosevelt administration (through 1940). In other words it still seems likely that T.V.A. will arrange for public ownership and operation of the larger transmission and distribution facilities of a considerable area. The result will be cheaper power, both because it is subsidized by low cost money and by some other hidden measures of relief from taxes or other expense which must be borne by privately owned enterprise of equivalent scope. More than the nose of the public-ownership camel remains in the utility tent.

Those who view the T.V.A. situation impartially (assuming that anyone can) seem to conclude about as follows: There was much stubbornness and probably some stupidity in the administration of each of the three larger divisions of T.V.A. It is unlikely that there was any dishonesty; nothing more than sharp practice for a "good cause." Certainly it is most unlikely that it will be proved that anyone lined his personal purse, or even his friends' billfolds, at public expense.

The President himself was probably mainly to blame for the lack of cooperation which has caused recent difficulties. He frequently conferred with the different directors and seemingly sent each of them away from such conference with the feeling that his particular part of this project had the President's unlimited support. The President has certainly consistently declined to require, or even to urge, joint action of

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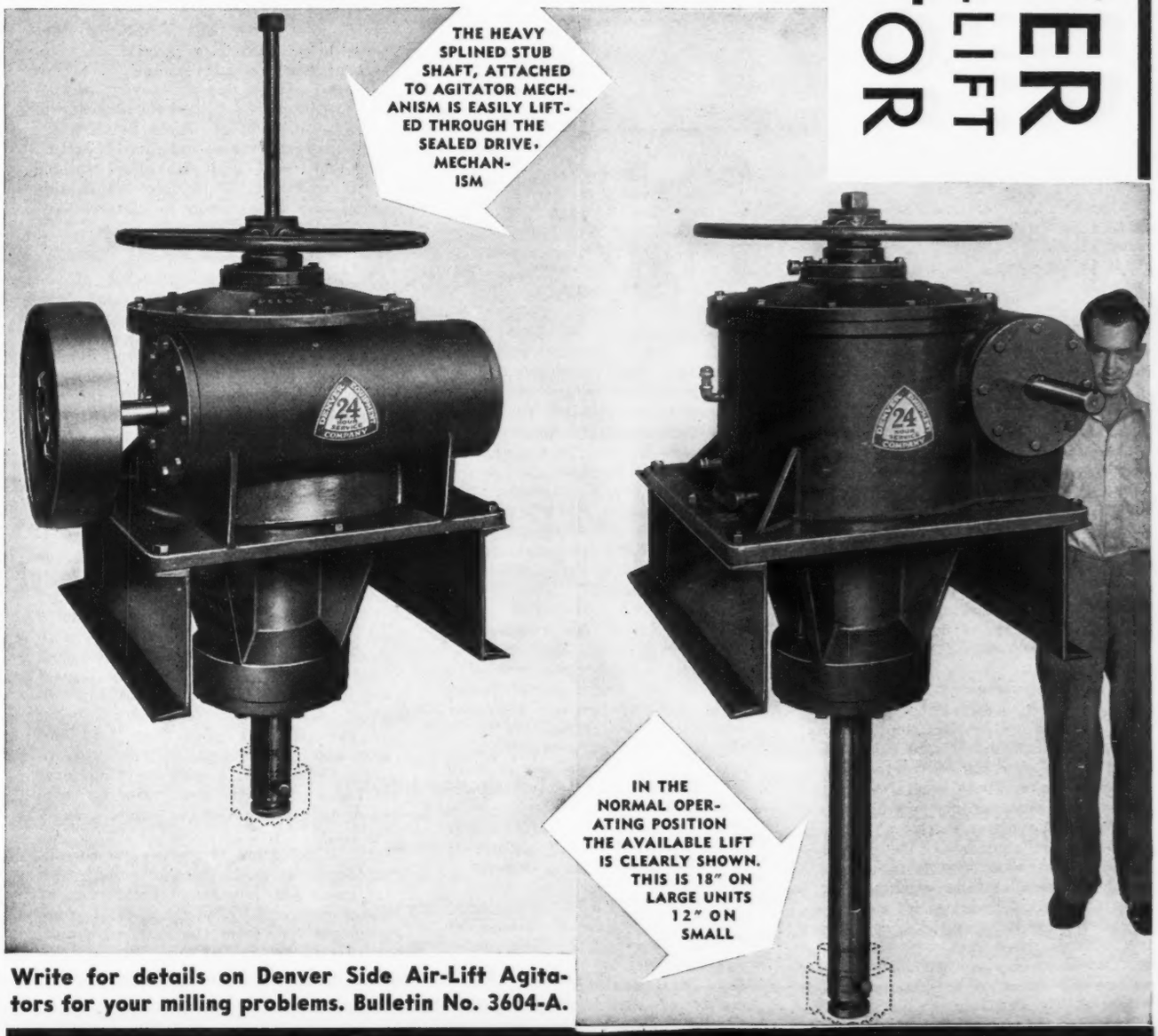
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the three directors on the three diverse objectives which were usually nonconflicting. Hence, when occasionally there was conflict between social reforms and power policy or between dam building and power selling there was no unifying influence to make the three directors act as a single official body.

There is nothing new in this particular situation except the intensity of feeling and the openness of controversy. Washington rather expects that ultimately all three directors will have to be removed in order to reestablish T.V.A. on even the semblance of a working basis. Personalities have gone so far that many members of Congress are privately demanding a complete housecleaning. They are impatient with, and will refuse appropriations for, directors who have shown that they can't get along with other folks.

The inevitable noise surrounding the Congressional inquiry will not do much to straighten out or make more accurate the fundamental "yardstick." But it is far from safe to conclude that the failure of T.V.A. proves that the Government cannot go into business enterprise. It may to many prove that the Government *should* not; but it will not persuade Congress that the Government *will* not. The injection of Government into business has, however, been definitely slowed down.

Labor Philosophy

"BUSINESS MEN can largely determine the character of labor unions with which they deal." This is not the statement of an individualist or economic royalist. It is the substance of the theory on which one high official important in labor projects of the Government states his conclusions. The reasoning by which he reaches the conclusion is particularly important for any mining executive looking forward over the next few years of dealings with his own company workers. It goes something like this:

If the company executive accepts the idea of labor unionization gracefully, and as a thing which has come to stay, he removes from the field of controversy much of his own future trouble. Such executive makes it unnecessary for the head of the union of his own employees to prepare for bitter battles on renewal of wage-hour contracts. He even encourages the union officials to work for the betterment of the company as a basis of the betterment of its employees.

Under these circumstances, so reasons this official, union men will select conservative members as their leaders. The union will be able to choose officers whose ability and interest lie in a constructive rather than in a controversial area. The result will be fewer fights, no strikes, and actual support of management by workers. If the management takes an opposite view, continues to fight against unionization, thinks of the union leader as its enemy, and makes every grievance a cause for battle, the union policy is also reversed. Fighters are chosen by the unions as their officers. Every episode is judged from its tactical significance, not as a mere minor event requiring adjustment. Bitter feelings are stirred, and minor troubles become major difficulties over night.

On this philosophy some of the cooler-headed longer-visioned officials of Washington are proceeding with their conscious effort to sell business men on modern labor relations. In the case of many career officials, and some important New Dealers, this philosophy is seriously accepted as the only sound basis of procedure. More radical reformers are obviously using it as window dressing. But all take the labor stand that not only does the law require union negotiations of the business executive, they argue also that all social trends of the world demand this, irrespective of what the law might be.

Mining industry executives can make their plans with full confidence that these broad principles govern the more conservative Federal officials. Whether they agree with the philosophy, or like it, it will govern behind-the-scenes procedures of much of Uncle Sam's staff. But there is no reason to believe N.L.R.B. leadership will *limit its effort* to the more conservative practice which this philosophy might seem to dictate.

LEND OR SPEND?

LOANS TO MINING are preferable to gifts to miners. This is a very free interpretation, but substantially correct, of the present administration attitude regarding measures of relief. Uncle Sam would rather lend his way out of the present depressed business situation than merely spend for relief of individuals.

RESUMING OF LOANS to industry, including mining, interrupted last October by Reconstruction Finance Corporation, has resulted in some small measure of business stimulation, but very little of the money goes into the mining or mineral industries as in earlier periods of difficulty. Managements of such business have difficulty in meeting the terms of R.F.C. banking operations. Reinvestigation of some pending cases may result in a few new loans, but those will probably be a negligible part of Uncle Sam's new activity. Far more significant for all business is the plan of regional industrial banking, which is taking form during the later part of March. This program, sold to the President with difficulty, contemplates long-term capital for business by Government purchase or underwriting of bonds or stocks. The effort will be to give that service to enterprise which formerly was offered by the national banks, now forbidden to make such long-term investments.

PRESUMABLY the requirement of securing S.E.C. approval for any new security will remain a part of the new regional industrial bank program. But the commissioners of S.E.C. are really striving to simplify procedures a bit in order to speed up security issues. They know that capital funds have dried up in many areas to the point that reemployment on projects of industrial enlargement is proving difficult.

SHORTLY AFTER mid-March, Commissioner John W. Hanes, of S.E.S., interpreted the fundamental policy of that agency to the Investment Bankers' Association of America. He gave official recognition to the need for about $7,000 capital investment for each man put to work. On this philosophy he emphasized the need for many billions of new capital to absorb present out-of-work employables. Despite these gradual changes in policy, and promises of new money aid to business, the relief bill of Uncle Sam will be large this year.

Mine Tax Proposals

IN BEHALF of all branches of the mining industry, the American Mining Congress urged the following amendments to the revenue bill when it was under consideration before the Senate committee on finance:

"1. Complete elimination of the undistributed profits tax and substitution therefor of a flat rate of corporation tax.

"2. Relief from the undistributed profits tax, as to those years to which it may be applicable, in the case of certain provisions which experience has demonstrated produce hardship or injustice; specifically (a) As to sinking funds set aside in the normal course of business after the close of the taxable year; (b) as to the allowance of a reasonable period following assessment of a deficiency within which distribution of dividends may be made as a dividends paid credit; (c) as to expenditures for construction, equipment and development or for payment of indebtedness not otherwise provided for.

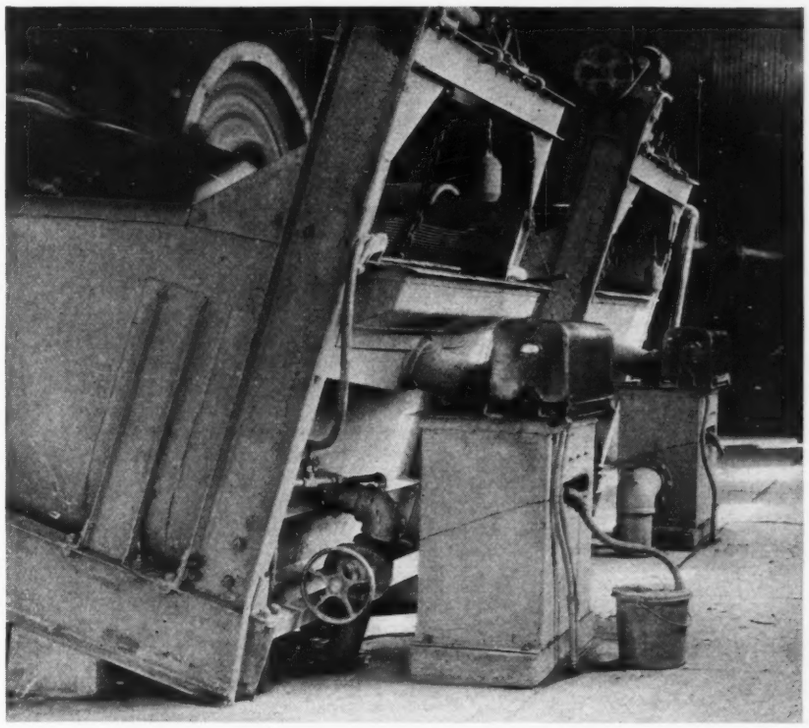
"3. Provision for the carrying over of losses of at least two preceding years as a deduction from the current year's income.

"4. Elimination of the present complicated provisions for recognition of capital gains and losses and restoration of a flat rate of 12½ per cent on the net gain realized from the sale of capital asset held for more than one year.

"5. A provision that a new declaration of value of capital stock for purposes of capital stock and excess profits taxes be allowed in 1938 instead of 1939, and that redeclarations of value be permitted thereafter every two years instead of every three years as provided in the House bill.

"6. Allowance of losses due to obsolescence.

"7. Recognition, in the provisions dealing with inventories, of the established practice in the mining and metallurgical industry of balancing current sales against current purchases or intake, through recognition of what is known as the 'last in, first out' method."



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Electrolytic Zinc Plant On Three-Day Week Basis

Sullivan Mining Company curtails production 50 per cent—More base-metal mines reduce their output—Recent airplane service aids mining in winter months

▶ Low base-metal prices are continuing to handicap operators in the Coeur d'Alene mining district. Effective April 1, employees of the Sullivan Mining Company's big electrolytic zinc plant at Kellogg went on a three-day week basis. This represents about a 50 per cent curtailment of operations and affected more than 200 men. Superintendent Wallace Woolf attributed reduced operations to rising zinc stocks and low prices. The plant is now operating one of its three-cell units.

▶ The Sherman mine, in the Burke area, cut off one-third of its operating crew, with future operations depending entirely upon base-metal prices, Henry L. Day, manager, reported.

▶ The Hercules mill, in Wallace, handling the output of the Dayrock, Sherman, and Tamarack mines, has reduced operations from two shifts to one shift daily.

▶ Placer operations are expected to get under way on Burdette Creek, in the Lolo national forest, this spring. Dredges will be erected on gold areas tested by drilling.

▶ Articles of incorporation for two new mining companies which will operate in central Idaho have been filed with the Secretary of State at Boise. The Maggie Creek Mining Company has a capital stock of $50,000, divided into 485,000 shares of common and 15,000 shares of preferred. Offices of the company are at Seattle, Wash. The Gold Bar Placer, Inc., with offices in Spokane, Wash., filed papers to engage in general mining, designating L. O. Stout, of Whitebird, Idaho, as agent. The company has a capital stock of $10,000 divided into a million shares valued at 1c. each.

▶ Plans for a resumption of operations at the Bobby Anderson Group Mining Company's property, on Pine Creek, are now well advanced. Par value of the stock was recently changed from $1 per share to 1c. Capitalization is 2,000,000 shares.

▶ Development operations will be resumed this spring at the Cinnabar group of claims, North Fork River district, according to Jerry Carter, principal owner. A crosscut tunnel on the Cinnabar vein revealed carbonate ore showing high silver values.

▶ Recent ore found on the 1,900-level east drift from the Sunshine mine into the Polaris ground is reported to contain high silver content. The vein is reported 8 ft. wide and the ore has been followed for 50 ft. Development of this ore is under a joint agreement between the Sunshine and Polaris companies, proving the existence of an orebody far below the present shaft at the Polaris mine.

▶ Silver Summit Mining Company has elected Harry P. Pearson as president; William M. Yeaman, Yakima, vice-president; Martin Nicholson, secretary-treasurer; Byron Wilson and H. J. Hull, Wallace, directors. Preliminary work is under way at the property to put down a 1,000-ft. shaft. The management is now installing 5,700 ft. of electric cable from the portal to the shaft station.

▶ Aviation is playing an important part in the Idaho mining industry. A number of properties in central Idaho now operating depend entirely on airplanes for existence in winter months when roads are snow-blocked. From Cascade to Yellow Pine, Stibnite and on to Deadwood, formerly a four-day trip by dog team, now has been cut to 25 minutes by air. Mining activities continued throughout last winter in Atlanta, Stibnite, Deadwood, Warren, Mackay Bar, Crooked Creek, and other isolated towns. Each of these communities is separated from rail service by mountains 8,000 ft. above sea level. Not only the sick or injured are now served by air transportation but passengers and mail are carried on scheduled runs. At the Sunny Side mine, at Thunder Mountain, commodities are dropped from the plane. Eggs and fragile goods are dropped by parachute. Since April, 1937, the Johnson Flying Service has transported by air 150,000 lb. of equipment from McCall to Mackay Bar. Included in the equipment were a hydroelectric plant capable of developing 500 hp., one air compressor, eight gas-engine power plants, two donkey engines, weighing 6 and 9 tons; several thousand feet of ¾- to 3-in. pipe in 22-ft. lengths, 50 bbl. of gasoline, and many other supplies necessary to maintain mining operations. The largest single piece transported weighed 2,300 lb. A Ford tri-motored plane was used to carry the heavy equipment, the average weight per trip being 4,100 lbs.

Crescent mill of Bunker Hill & Sullivan Mining & Concentrating Company in Big Creek, near Kellogg, Idaho, produced 907,797 oz. of silver, 261,292 lb. of copper, and 189,881 lb. of lead during 1937

NEVADA

Getchell Mine Ships First Bullion

Metallurgical results at new plant satisfactory—Silver Peak district active—Work suspended at Ruby Hill mine

▶ First bullion has been shipped from the 600-ton mill of the Getchell Mine, Inc., in eastern Humboldt County, which has been treating around 300 tons per day while awaiting delayed equipment for completion of the roasting plant, now in operation. W. H. Gould designer of the 7x100-ft. rotary furnace, has been at the mine. Noble H. Getchell is vice-president and manager.

▶ Silver Peak district, in Esmeralda County, active in the early 'sixties, long a "ghost" camp, is Nevada's outstanding example of successful reopening of old precious-metal mines. Within the past four years options were obtained by Fred A. Vollmar, Jr., on the property of the Silver Peak Gold Mining Company. E. L. Cord, retired automobile and airplane manufacturer, has provided funds for mine development and mill construction. Equipment of the 350-ton flotation mill of the Como Mines Company was purchased and a deep-level tunnel has been driven in the Mary mine. The new mill, near the portal of this tunnel, is nearing completion and will treat custom ore, including the product of the Vanderbilt mine.

▶ Shipments of high-grade copper ore and flotation concentrate by the Mountain City Copper Company, Anaconda subsidiary, have been curtailed by storms that closed the road south to Elko. The longer road north to Mountain Home, Idaho, softened by rains and

melting snow, was cut up and rendered nearly impassable by the heavy 25-ton trailer trucks. Several companies have continued active development of adjacent groups of copper and silver-gold claims.

▶ Following a recent visit to Eureka by Dr. W. F. James, of Toronto, president of the Eureka Corporation, Ltd., work was suspended on the Ruby Hill mines, held under option, excepting for small-scale work in the Phoenix and Jackson mines to retain options. Diamond drilling will continue in the effort to find extensions of the Richmond-Eureka orebodies. Glenn Anderson, manager, indicated that excessive taxes had resulted in an operating loss in the face of smelter shipments of 100 tons per day.

▶ Arizona Comstock Corporation in 1937 milled 135,740 tons of gold-silver ore, nearly all from its open cut on the outcrop of the Comstock lode. In February surface mining by power shovel was greatly curtailed by storms and by caving of the west wall of the open cut, but production is again normal at around 11,300 tons per month. W. J. Loring, president, reports that the enlarged cyanide mill is now treating 80 tons per day of impounded flotation tailing. Crosscuts are being driven in the Hale & Noreross mine below the open cut to make available large bodies of blocked underground ore. Reports by four engineers have appraised the underground reserve of mill grade at upwards of 1,000,000 tons.

IRON COUNTRY

Shipment of 35,000,000 Tons Estimated for 1938

Some stripping programs completed—Butler Brothers suspend operations at Merritt mine, on Cuyuna Range

▶ Conditions on the iron ranges of Minnesota are quiet, and practically all mining operators are working on a four-day per week schedule, giving the employees as much time as they can. Most of the stripping operations have been completed with the exception of the Scranton mine work at Hibbing and the Oliver Iron Mining Company's work at the Hibbing, Chisholm, Virginia, and Coleraine districts. No change has been made in the rate of wages—the only change being, as reported previously, a cut in the salaried men's pay checks.

▶ Operators believe that the ore season will start slowly and accelerate as the season gets under way. The best estimate of ore shipments at this time would be about 50 per cent of the 1937 shipments, or between 30,000,000 and 35,000,000 tons.

▶ At the annual meeting of the Mesabi Iron Company to be held in Wilmington, Del., on April 15 abandonment of the railroad spur to the plant at Babbitt Mine will be proposed and also the sale of some of the equipment at the mine. The Mesabi Iron Company has large reserves of magnetic ores on the eastern Mesabi range and spent several million dollars erecting crushing and sintering plants, but as the price of iron ore is too low for profitable operation at this time, it was decided to sell some of the plant equipment, as it would be necessary to modernize the plant in case the price of ore and the demand should again be profitable.

▶ Consumption of iron ore by furnaces during January amounted to 1,923,056 gross tons. As of Jan. 31, 1938, 70 blast furnaces were operating on Lake Superior iron ore, compared with 141 a year ago. The amount of Lake Superior iron ore on hand at furnaces as of Feb. 1 was 38,881,832 tons. This figure includes both Lake Front balances and furnace yards.

▶ Butler Brothers have closed the Merritt Mine, on the Cuyuna Range, for an indefinite period and practically all operations are on a restricted basis wherever production is under way on their properties.

American Zinc Institute Meeting, April 25–26

▶ The 20th annual meeting of the American Zinc Institute will be held at the Hotel Statler, St. Louis, Mo., on Monday and Tuesday, April 25 and 26. On Monday there will be a report of the Institute's activities during the past year. A novel close-up of the Institute's promotion work will be presented. Happenings in Washington, and the outlook for zinc, are among the topics to be featured.

The program on Tuesday will include topics relating to developments in zinc coatings and the market for zinc-coated products. Technical and operating men in the galvanizing division of the steel industry will join and share the platform. Entertainment features will include the annual dinner, which will be held on Monday evening. Branch Rickey, manager of the St. Louis Cardinals, will be one of the guest speakers.

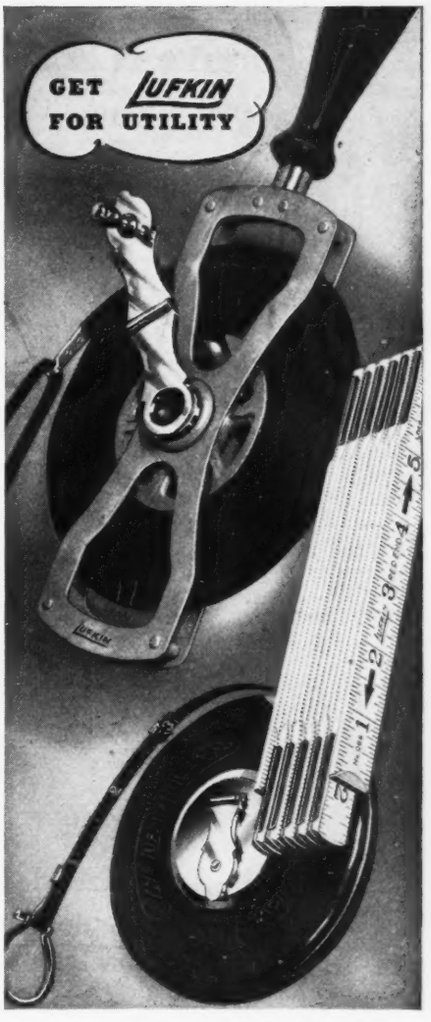
TRI-STATE

Lower Zinc Price Depresses Activity

Small operators experience difficulty in selling concentrates—Rialto Mining Corporation reemployes men

▶ Production in the Tri-State district has been maintained at better than 7,500 tons of zinc concentrates and 1,200 tons of lead concentrates per week during the month of March in spite of the threat of lower concentrate prices. Concentrate sales have dropped off rather drastically the latter part of March and it is expected that some of the smaller operators will be forced to shut down because of inability to sell their concentrates.

▶ The Rialto Mining Corporation reopened its mine and mill the first part of March after being idle since October



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of last year. Approximately 110 men were reemployed according to Sam Ashe, superintendent for the company. The mill was overhauled and the underground rope haulage system was extended while the property was idle.

▶ Eagle-Picher Mining & Smelting Company has drilled out sufficient zinc and lead ore on the Shinn land near Stark City, Mo., to warrant unwatering and sinking the present shaft to a depth of 230 ft., according to G. C. Niday, general superintendent of Tri-State mines for the company. The mine had been first developed about twenty years ago and was reopened last year by the Manda Industrial Corporation. The ore will be transported by rail to the Central mill of the company near Commerce, Okla.

▶ Frank J. Cuddeback and associates are reopening the field shaft of the Red Dog mine, in the old North Webb City camp. The ore will be trucked to railroad cars in the Oronogo bottoms and shipped to the Central mill of the Eagle-Picher Mining & Smelting Company.

MICHIGAN

Low-grade Amygdaloid Copper Sands Treated

Calumet & Hecla's reclamation plants recovered an average of 9 lb. copper per ton during 1937

▶ Mines of the Calumet & Hecla Consolidated Copper Company produced 53,876,000 lb. of copper in 1937, according to the annual report of the company. The reclamation plants at Lake Linden and Hubbell produced 20,398,000 lb. Average cost sold per pound was 7.59c. and 6.63c., respectively, not including depreciation and depletion. Average selling price for the year was 14.11c. Only three shafts of the Conglomerate mine of Calumet & Hecla now are in operation. Of these, Nos. 6 and 7, Hecla, will be exhausted during the current year. The life of No. 12, South Hecla, is estimated at approximately fifteen months. New ground opened in No. 2, in Allouez territory, is of slightly poorer grade than that mined the previous year. Tons of sands treated at the Lake Linden and Hubbell reclamation plants totaled 2,226,000, yielding 9.16 lb. of refined copper per ton. Dredges at both plants are working in areas necessitating inclusion of overlying low-grade amygdaloid sands in order to treat underlying and richer conglomerate. Diamond-drilling operations conducted in Keweenaw County by Calumet & Hecla have disclosed the position of the various lodes and indicated in a broad way the character and distribution of mineralization. No lodes of commercial importance have so far been found. At the St. Louis exploration, considerable heavy copper occurs in disconnected shoots in a wide mineralized fissure zone. The erratic distribution of the copper makes it impossible to state at present whether or not this disclosure may later lead to something of commercial importance.

▶ In Calumet & Hecla's gold area in the Ishpeming, Mich., district, the great length and width of the Ropes shear zone, with its intense rock alteration and traces of gold, give basis for the hope that values will somewhere be found to persist.

CANADA

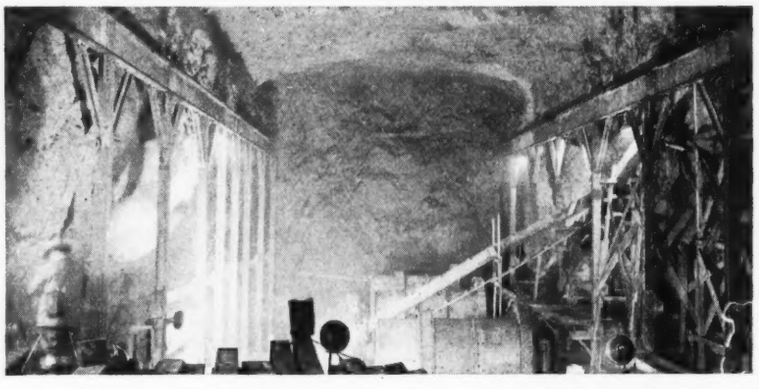
All Provinces Increase Metal Output in 1937

British Columbia advances value of mineral production 34 per cent—Gold mines plan greater activity this year—Underground mill at Big Missouri begins operating

▶ In 1937 gold production for the Dominion was valued at $143,314,561, maintaining first place among Canadian minerals for the seventh consecutive year and an increase of 9.3 per cent over the figure for 1936. Copper production increased 74.7 per cent in value to $69,049,734; nickel increased 35.6 per cent in value to $59,507,176; lead increased 40.1 per cent to $21,013,404; zinc increased 64.4 per cent to $18,157,894; silver increased 23.0 per cent to $10,180,371; platinum metals increased 28.1 per cent to $9,933,709; cadmium increased 74.5 per cent in value to $1,220,867. Asbestos is shown in revised statistics to be the leading non-metallic mineral (not including coal, natural gas and petroleum, which had a total value of $65,778,137) and increased 45.7 per cent to a value of $14,505,791. Cement, clay products, and other structural materials increased about one-third above the record for 1936, to a total value of $34,401,669, bringing the grand total of mineral products from Canadian sources in 1937 to $456,793,260, an increase of 26.2 per cent over the figures for the preceding year. Among the provinces, British Columbia advanced 34 per cent to $73,143,717; expansion in Quebec led to a new high in mineral output at $65,089,194.

▶ Official operating figures included in recently issued annual reports have made posible certain revisions in statistics for the following group of mines, supplementing those appearing on page 53 of the February *E. & M. J.*

	Gold Recovery per Ton	Working Costs per Ton	Daily Tonnage
Manitoba			
God's Lake Gold Mines	10.19	7.06	169
San Antonio Gold Mines	9.09	5.14	317
Quebec			
Canadian Malartic Gold Mines	4.51	2.57	636
Siscoe Gold Mines	13.13	4.76	549
Ontario			
Buffalo Ankerite Gold	8.26	4.64	940
Central Patricia Gold Mines	18.06	7.95	211
Coniaurum Gold Mines	8.76	7.26	457
Hollinger Cons. Gold Mines	8.99	4.84	4,762
Howey Gold Mines	2.20	1.38	1,226
Macassa Mines	16.16	6.62	248



Big Missouri underground mill of the Consolidated Mining & Smelting Company started operations in March treating 500 tons ore daily. Ball-mill section is shown above

▶ Hollinger Consolidated Gold Mines reports favorable developments for two subsidiary mines in Ontario, the Young-Davidson, in the Matachewan district, and the Ross, in Hislop Township. The Young-Davidson mill averaged 930 tons daily in 1937, maintaining ore grade at $3.34. Hollinger advances were repaid out of production to the extent of $318,615. The Ross mine is developing two ore zones.

▶ Promising results have come from the 200-ft. level of Central Cadillac Gold Mines, according to information from the consulting engineer, R. C. Bryden. Approximately 4,400 ft. of diamond drilling has been completed from surface and 1,500 ft. of underground drilling. To date eight vein systems have been opened, with an ore length of 235 ft. proved on the main, or No. 8, vein. Values average $21.62 over a width of 5 ft. A long drive is being put out to the west on the bottom 200-ft. level for the

Canadian Mining Engineers Meet in Annual Session

Toronto entertains largest gathering in the history of the Institute for discussion of technical problems and award of honors for conspicuous service

ATTRACTING the largest attendance in its history, the Canadian Institute of Mining and Metallurgy held its 39th annual general meeting at Toronto, March 14–16. Registration exceeded 1,500, indicative of the parallel growth of the Institute with the expansion of the Canadian mining industry.

Prominent among the technical papers presented, which will be published in the Institute's *Bulletin*, were one dealing with shaft sinking and one with research on the prevention of silicosis. R. M. Oliver, chief mine engineer of the Falconbridge Nickel property, described an unusual method for sinking through 100 ft. of overburden consisting of gravel, sand, and boulders with bands of fine silt and a layer of water-bearing quicksand. The shaft was sunk by digging inside a steel shield that was jacked down as the work proceeded. At a depth of about 100 ft. it was found that the bedrock fell away steeply on one side to a sheer cliff in one corner. Dowel holes were drilled, and a 26-in. wall of concrete 5 ft. high was poured inside the shield around two-thirds of the shaft. Interlocking steel piling was then driven around the remaining third, and the work of sinking proceeded. Three eight-hour shifts advanced the sinking through the overburden about 6 ft. per day at a cost of $282 a foot, exclusive of any cost for plant or power.

J. J. Denny made a progress report on the research being conducted by McIntyre Porcupine Mines, Ltd., in cooperation with the Banting Institute, on the use of aluminum dust in the prevention of silicosis. (*E. & M. J.* Sept., 1937, p. 47.) The dusting experiments with rabbits previously described are being repeated, and further animal experimentation is under way to determine effective methods of applying aluminum dust for the protection of underground workers. Inasmuch as the concentration of aluminum dust for this purpose would be far below the explosive limit in air, no danger from that source is to be expected.

A feature of the presidential address of the Hon. Michael Dwyer was his emphasis on the need of training young men for work in the mining industry. He described the procedure adopted by the Province of Nova Scotia, where arrangements have been made between employers and the government for apprentice training. Young men of good physique, between 19 and 25 years of age, are engaged to learn methods of mining and milling under the direction of trained engineers and experienced operators. They move successively to new jobs and increased responsibility until they have qualified for a certificate of competence. During training they receive free board, a cash allowance of 50c per day, and suitable clothing. Classroom and field instruction are also given by competent engineers and members of the staff of Nova Scotia Technical College. About 100 young men are in training now.

Awards of Institute honors were made in a dignified and impressive ceremony at one of the luncheons. Robert Lepsoe, research engineer for the Consolidated Mining & Smelting Company, received the platinum medal of the International Nickel Company for his work on the recovery of sulphuric acid and elemental sulphur from smelter fumes. The Randolph Bruce gold medal was awarded to E. L. Longmore, metallurgist of Hollinger Consolidated Gold Mines, Ltd., for notable contributions to the art of milling gold ores. Dr. H. C. Gunning, of the Canadian Geological Survey, received the Barlow Memorial prize for the best paper on applied geology submitted in 1937. Accident prevention prizes donated by Mines Safety Appliances Company, Ltd., were awarded, first to W. E. Montgomery, safety engineer, Quebec Asbestos Producers Association; and, second, in equal merit, to G. F. Brink, Asbestos Corporation, Ltd., and J. H. Janes, Queen's University. Prizes for the best technical papers submitted by students were awarded, in equal merit, to J. B. Hodgson and J. D. Hall, of McGill University, and to E. B. Wright, of Queen's. The medal for bravery, "The Victoria Cross of the Institute," annually donated by E. A. Collins, president-elect of the Institute, was conferred on Harold Beck, Joseph Franko, Lance Martin, Donald Randall, Edward Rogers, Walter Salach, and Charles Start, all of Port Colborne, for heroic action in rescuing fellow workers overcome by noxious gas.

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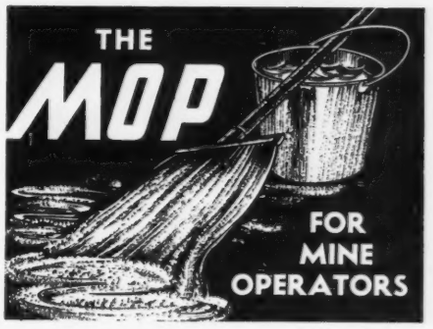
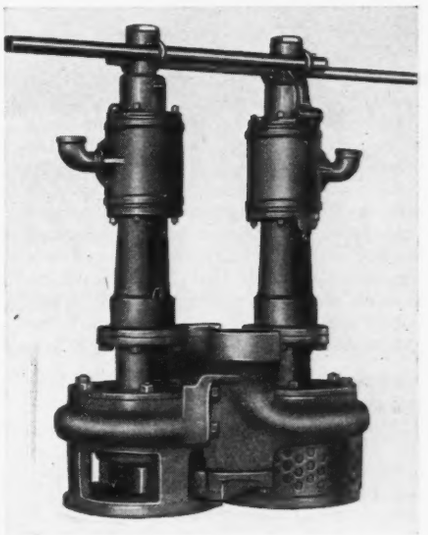
purpose of testing an ore zone which appears to be similar to the important No. 4 vein at the O'Brien mine. The long drift has encountered visible gold which checks up with drill intersections on the 400-ft. horizon.

▶ Construction of a cooperative custom mill is being discussed for Cadillac Township, northwestern Quebec. Interest in such a project has been shown by four operators who have moderate tonnages blocked out, but whose plans for independent mills are contingent on further exploratory work and better financing conditions. The project, a departure for Canadian mining practice, is expected to give participating mines expert technical supervision that would result in lower costs and improved recoveries.

▶ Treatment of low-grade ore at Central Patricia Gold Mines from lower levels has had the effect since the first of the year of reducing mill heads almost $3 below mine average. Last year





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▶CANADA

the recovery per ton was $18.06. Three new deep levels in the main ore zone have been meeting satisfactory results down to a depth of 1,450 ft., and work to the west has proved a new orebody of considerable value. Known as the "G" oreshoot and located 500 ft. west of the main workings, the new ore was first opened on the 375 level. The No. 2 shaft will be deepened this spring and ore will be raised through it at the rate of about 25 tons daily.

▶Pamour Porcupine Mines, controlled by Noranda, started milling in May, 1936, at 500 tons a day. Last year the average handled was 723 tons, but in March new equipment was put into service which more than doubled the previous capacity. Underground developments have been so rapid at this remarkable property that upward revised tonnage estimates were made soon after the first mill unit was completed and it is considered possible that further mill expansion will be undertaken. Daily output is now reported at 1,450 tons. The grade is expected to be under $7 a ton.

▶Leitch Gold Mines, at Beardmore, Ontario, began milling operations in January a year ago and has now reached the objective of a monthly output of approximately $60,000. The average per ton recovery in February was $22.97. President of the company is K. J. Springer.

▶The 1937 annual report for San Antonio Gold Mines details the successful campaign to explore No. 38 vein on the ninth and tenth levels. President J. D. Perrin reports positive ore reserves at 256,516 tons, a higher figure than at any other time since production started, in 1932. D. J. Kennedy is mine manager.

▶Beattie Gold Mines show ore reserve position in January at 4,547,120 tons grading 0.142 oz. In the annual report issued by Thayer Lindsley, president, it is explained that lower profits in 1937 were due to a slight reduction in grade and to the loss of time that resulted from breaking in the new roasting plant last October. Losses were also suffered in June when a slide occurred in the glory hole. W. B. Maxwell is manager.

British Columbia

▶Two mines have been developed to the producing stage and promising results are being obtained at a number of others in British Columbia's new gold camp—Zeballos, on the west coast of Vancouver Island. A modern community which soon will boast three hotels, a hospital, a bank, domestic water supply, sewage disposal, and electric light and power is growing rapidly on the rugged coast where a year before there were only a few fishermen's shacks. A 50-ton mill, a diesel power plant, and a camp to accommodate 60 men are being constructed by Spud Valley Gold Mines, Ltd., at the Goldfield mine. No. 8 level has been started 550 ft. below the present deepest adit, No. 4, and at a total depth of 1,100 ft. below the outcrop. A quarter interest in the Privateer mine, the other property developed to the point of production, has been acquired for $374,000 by Connell Mining & Exploration Company, Ltd., of Toronto. Ore carrying high values across a width of from 7 to 12 in. has been opened at the 900 level for a continuous length of 800 ft. to date, and ore in a parallel vein has been opened for a distance of 250 ft. to date at the 1,000 level. Ray Pitre is in charge of operations.

▶Operation of the new 500-ton underground mill at the Big Missouri gold mine, Portland Canal district, was commenced in March. The underground location of the mill was decided upon by the Consolidated Mining & Smelting Company, because of the heavy snowfall in the region and the low costs made possible. The mill chamber was formed by excavating 80,000 tons of rock. It is at the 2,100 level, 200 ft. below the 2,300 or main haulage level. The ore is hauled 2,000 ft. at the 2,300 level by two 4-ton motor trams from two main muck raises, and dumped in a 1,000-ton coarse-ore bin. It is then passed through jaw and gyratory crushers, three ball mills, and flotation machines. The concentrate is cyanided. A hydroelectric power plant provides 2,400 hp. for the company's operations. D. S. Campbell is general superintendent.

▶It is expected there will be a revival of interest this season in lode mining in the Cariboo district. Good results are being obtained at the Cariboo Gold Quartz and Island Mountain, at present the only two producing lode mines, and a 100-ton mill is being constructed at the Cariboo Hudson, 21 miles southeast on the same mineral belt. Development of the Proserpine and Rand groups is also to be undertaken this year by strong financial interests. The Cariboo Gold Quartz Company recently acquired two miles of ground, increasing its holdings to five miles along the favorable belt. The milling capacity was increased in February from 250 to 275 tons a day. Island Mountain Mines, a subsidiary of Newmont Mining Corporation, had a gross income of $487,223 in 1937, of which $140,879 represented operating profit. At the 3,500 or lowest level, limestone replacement orebodies having an aggregate length of 200 ft. have been opened to date.

▶Consolidated Nicola Goldfields, in the Kamloops district, has opened an orebody having an indicated length of 300 ft. and carrying gold and silver values of between $8 and $12 per ton across 5 ft. at the 320, 440, 550, 675, and 800 levels, according to John F. Coats, manager.

▶A three-compartment shaft is being sunk at the Canty gold mine, at Hedley, to a depth of 500 ft. Levels will be driven this summer at 250 and 500 ft. to open orebodies found by diamond drilling. C. R. Cox is superintendent.

▶At the Kootenay Belle, near Salmo, commercial values have been opened at the 4th level in a section of the vein that was barren at the 3d level, 314 ft. above, and it is expected good results will be obtained when the more productive section is reached. Profits of about 20c. a share were earned during the past year, and an interim dividend of 5c. has been declared. Output in February had a value of approximately $46,000.

▶Ore is being developed satisfactorily in the 8,000 vein at the 2,100 level of Gold Belt Mines, and the main crosscut is being continued to the 8,200 vein.

▶Two additional flotation cells have been installed at the new mill of Durango Gold Mines, near Ymir, increasing its daily capacity from 85 to 100 tons. The president, Nelson S. Smith, of Vancouver, reports that net smelter returns in February were $33,059. Zinc concentrate is being stored at the mine until a higher price can be obtained.

▶At the New True Fissure mine, near Ferguson, in the Lardeau district, 45 tons of ore is being milled per day. Lead concentrate is shipped to the Trail smelter and zinc concentrate is stored at the mine, pending an improvement in metal prices.

BRITISH ISLES

Cornwall Mining Declines As Tin Price Drops

South Crofty still maintaining some production—East Pool and Great Tin Mines suspend operation—Lead mine in Darbyshire threatened by flooding

▶The decline in the price of tin and the unpromising outlook for the metal are having a bad effect on mining in Cornwall. Development results not having proved up to expectations, the East Pool mine, which has been worked almost continuously for a century, will mine out developed ore reserves and then withdraw the pumps. Continued expenditure on development is adjudged not to be warranted with tin at its prevailing price. The owning company is East Pool & Agar, of which Captain A. H. Moreing is chairman.

▶It has been feared in some quarters that South Crofty, nearest neighbor of East Pool, may be flooded by the withdrawal of the latter's pumps. South Crofty is operating successfully and paying dividends. In February it produced 56½ tons of black tin, recovery averaging 26.03 lb. per ton milled, and also by-products which sold for £182. John H. Trounson, vice-president of the Cornish Institute of Mining Engineers, says of the possibility of flooding that there is no ground for serious anxiety. The only part of East Pool connected with South Crofty can readily be dammed. South Crofty has always had a large flow of water to deal with and has installed adequate pumping equipment.

▶Another Cornwall property, Great Work Tin Mines, is suspending opera-

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A battery of HENDY Giants tin mining in the Federated Malay States

Below: HENDY Giants operated continuously for many years at the Logan Mine, Josephine County, Oregon. They are here shown working in conjunction with HENDY Gravel Elevators which are lifting gravel, and boulders up to 6" diameter into the sluice. ★

HENDY GIANTS AT PANAMA

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▶BRITISH ISLES

tions. This company was formed in 1934. Expenditure on dewatering the mine and reconditioning the plant has absorbed the capital provided, according to Major E. S. Marks, the chairman, and to carry out the original objective of sinking the Deerpark shaft a further 250 ft., and developing the ground between it and the Leeds, some £30,000 additional would be required. As it is estimated that a price of £210 per ton for tin would be required to justify such an expenditure, Major Marks suggests that the company's debts be met as far as possible and the property be held till something turns up.

▶ Nothing further is heard of the proposal that groups of Cornish properties be consolidated with the end in view of providing central hoisting and pumping plants, reducing the numbers of mills, and crosscutting hitherto undeveloped ground in search of additional ore measures; but it is understood that negotiations have not been abandoned.

▶ Flooding made it necessary to suspend all productive activities at the Mill Close mine, Derbyshire, England, late in February. Water rose 280 ft. from the 150-fathom to the 103-fathom level. A new pump has been installed which is handling 4,000 g.p.m., and additional plant has been ordered. Mill Close, largely owned by New Consolidated Gold Fields of South Africa and the National Mining Corporation, produces about one-third of the lead produced in the British Isles. During the 1936-37 year it paid 2s. 6d. and a bonus of 1s. in dividends on its 10s. par shares. J. A. Agnew is board chairman.

MEXICO

Government Expropriates Foreign Oil Properties

Statement by President Cardenas removes immediate threat of similar fate to the mining industry—United States Treasury defers continuance of silver buying program with Mexico

▶ Eighteen days after the Supreme Court of Mexico ruled on March 1 against the seventeen foreign oil companies in their wage conflict with workers, President Cardenas seized the oil industry under Mexico's expropriation law. On the following day, March 20, workers at the sixteen units of the Compañia Minera Asarco, S. A., went on a one-hour daily sit-down strike, seeking to enforce demands from the company for a blanket wage contract. The Federal Labor Board, however, apparently succeeded in discouraging this move on the part of workers, and this strike was cancelled. The Monterrey refinery and the Chihuahua smelter of the Asarco company were shut down during the latter part of March as a result of this brief strike, but early in April the Labor Board induced all workers to return to their jobs. On March 22 President Cardenas denied that other industries would be seized. He said in part: "Due to the peculiarity of the case, where all conciliation attempts were exhausted, the Executive was forced to decree expropriation as a totally exceptional measure and therefore, the latter will not be extended to other activities of the country which the Government looks upon with sympathy and considers necessary for national development. Therefore, the measures the Government will gradually take in relation to application of the decree of expropriation of the oil companies' properties will be those intimately related to the exploitation, adminstration, and the sale of oil products. "In view of this no other disposition will be issued which might affect the confidence of the country in other business on property, deposits, securities, and other investment which the Government is disposed to protect in accordance with the laws.

"This statement is issued by the Executive order in order to dispel the fear which without grounds might be created from rumors circulated by interested parties in which there are erroneous interpretations of the measures which the Government was forced to take in the oil industry's case. The Executive hopes that this statement will contribute to bringing normality of public feeling and also a clearer understanding of the problem which is being solved and that the nation will give the Government its support so that the country may continue its regular course without difficulties, since all measures which this Executive has taken or may take in the future has been inspired by the spirit of betterment of the Mexican people."

On March 27, Henry Morgenthau, Jr., Secretary of the Treasury, issued a statement that the United States Treasury will defer continuation of the monthly silver purchase arrangements with Mexico until further notice, as it desired to re-examine certain commercial and financial relationships with Mexico. On the same day President Cardenas, through a manifesto, informed the public of the action taken by the United States and asked that the move be judged with "serenity and justice." The Government, he said, is absolutely determined to continue its course, since it has a program it desires to complete as well as to meet the universal desire for national progress. He asked that producers give the Government their cooperation in order that Mexico's silver production may be put on the world market.

▶ Resumption of work is seen soon at properties in Parral, Chihuahua, of Esmeralda-Parral Mining, backed by Philadelphia interests headed by William P. Fairman. Work was suspended at these mines several years ago.

A peaceful plaza in this Mexican mining district affords opportunity to discuss advertisement of "Huasteca" and "Aguila," names of expropriated oil companies. Mines, like the one on the hill, however, are less talked about

▶ Monthly ore shipments from Sombrete Mines, Somberete, Zacatecas, Henry Wyman, president, are now averaging 2000 metric tons of silver-lead to American Smelting's Chihauhua and San Luis refineries and 1,500 tons of gold-silver to Fresnillo Company's plants, Fresnillo, Zacatecas. About 200 men are working. Mines expect soon to go on a three shifts a day basis.

▶ Cananea Consolidated Copper, Cananea, Sonora, Albert Mendelsohn, general manager, is now working 1,300 men, of whom 700 are engaged in the mines.

▶ Good gold prospects have led to plans for increased work by Cia. Minera Exploradora de la Sierra Candamena, Chihuahua, Vicente Arreola C., president. The company recently put a 50-ton flotation plant into operation.

▶ Equipment for increased work is soon to be acquired by David Coughanour for his gold-silver mines at Ocampo, Chihuahua.

▶ Labor peace was restored by Cia. Minera de San Rafael y Anexas, S. A., large silver mine operator in the Pachuca sector, Hidalgo, by granting a general wage increase of 50 centavos (14c.) a day and allowing triple salaries for work on legal holidays. The company also paid half wages for a "revolutionary

▶MEXICO

strike the workers waged for a day and 1,000 pesos ($280) as costs for delegates of the national miners' union who arranged the settlement.

▶ Monterrey Iron & Steel Works, Monterrey, Nuevo Leon, Mexico's largest enterprise of the kind, has installed machinery and other equipment at a cost of 1,000,000 pesos (some $280,000) to increase and improve production. Installations include a German bessemer converter, four ovens and a 50-ton crane.

▶ A cooperative society of employees is being organized by the Ministry of National Economy, to work the La Libertad mines, near La Paz, Southern Lower California.

▶ The present personnel of Mazapil Copper, Concepcion del Oro, Zacatecas, Leonides Gonzalez B., general superintendent, Jesus Norales, general manager, and W. F. Hooper, mine superintendent, is 700 men. The company contemplates several expansions if the copper market improves.

▶ Cia. Minera de San Carlos has obtained a Federal concession to use yearly 98,133 cubic meters of water of the San Carlos River, Ojinaga municipality, Chihuahua, for various mining works.

▶ The Chihuahua Government has founded a mining school at Chihuahua City.

▶ Compania de Inversiones del Oro, S. A., Madero 55, Desp. 208, Mexico, D. F., ceased to operate its La Noria unit on March 5. The company advises that purchase orders emanating from this company should be honored only if signed personally by Geoff. M. Wastenays, managing director; A. J. Geyne, secretary, or Ernest Ph. Herivel, general superintendent.

AFRICA

Ashanti Goldfields May Increase Mill Capacity

Favorable mine development on deeper levels lends support to view that output will be higher—Tanganyika Concessions, Ltd., seeks capital reconstruction

▶ There is talk, so far unofficial, of plant extension to give Ashanti Goldfields (Gold Coast, Africa) an output capacity of 40,000 tons monthly. Present capacity is less than 20,000 tons, and ore reserves are 1,955,100 tons averaging just under an ounce per ton. It is also claimed that selective flotation would reduce the considerable cost of roasting and quicken productive activities. February production was 18,496 oz. of gold from the treatment of 18,543 short tons of ore, and estimated net after all charges including depreciation was £78,805. Its profit similarly computed for the past five months together was £409,346. As development in the deep levels is particularly favorable, opinion is growing that the mine is not being worked on a large enough scale.

▶ The proposed reconstruction of the capital of Tanganyika Concessions, Ltd., reduces the total amount outstanding from £10,000,000 to £5,445,461. If and when completed, the company will be in a position to resume its mining exploratory activities which in the past have played an important part in the discovery and development of Central Africa's mineral wealth. The fact may have been forgotten, but Tanganyika Concessions promoted Union Minière du Haut-Katanga, the great Belgian Congo copper producer. It is now engaged with associated companies in equipping an important gold property in Tanganyika Territory, and with the same associates has in view the further exploitation and equipment of copper mines in Northern Rhodesia and Uganda.

▶ Minerals Separation, Ltd., the English company, reports a profit for 1937 of £158,023, against £57,489 in 1936. Royalties income was £102,475, against £49,317, and dividends and interest received £83,033, against £34,221. The increases in these two items were chiefly due to the activities of the Northern Rhodesia copper mines and to Mineral Separation's large holdings of Rhokana Corporation shares, on which it received the bigger dividends paid. Minerals Separation paid 50 per cent in dividends last year, against 25 per cent in 1936.

▶ Mining royalties received by the British South Africa Company, commonly called "Chartered Company," increased from £115,942 for the year to Sept. 30, 1936, to £296,015 last year. This was due almost wholly to the higher price of copper and the increased production of the Northern Rhodesia copper mines. The company's earnings for dividends rose to £686,650, from £521,514. By reason of its large holdings of Rhodesian copper shares, its income from dividends was some £72,000 larger. This company, formed by the great Cecil Rhodes, formerly owned the mineral rights over the whole of Northern and Southern Rhodesia. It sold its rights in Southern Rhodesia to the government a few years ago for £2,000,000, and its interests are now almost wholly in Northern Rhodesia and in the Rhodesia Railways.

▶ Six new gold-bearing reefs have been discovered underneath the city of Johannesburg. Excavation works at the new Jeppestown railway station and the construction of a new severage tunnel have exposed geological information of great value. Peter Macadam, the well-known Rand geologist, found four reefs at the Jeppestown station, which bear out Dr. E. T. Mellor's original geological survey of Johannesburg, which was undertaken 31 years ago. Two of the reefs belong to the Government Series and two to the West Coronation Series and the location of these particular reefs will serve as an important drilling indicator on the Far East Rand.

▶ Mining operations at the old Jagersfontein diamond mine will recommence within the next eighteen months. The

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plant will be reconditioned at a cost of £300,000 and the mine will operate on a big scale. Seventy Europeans and several hundred natives are at work already. The mine, which was closed down in 1931, produces high-grade blue diamonds.

AUSTRALIA

Mt. Morgan Plans Large Construction Program

Power plant and mill capacity to be increased and erection of a smelter is planned—Gold strike reported in Queensland

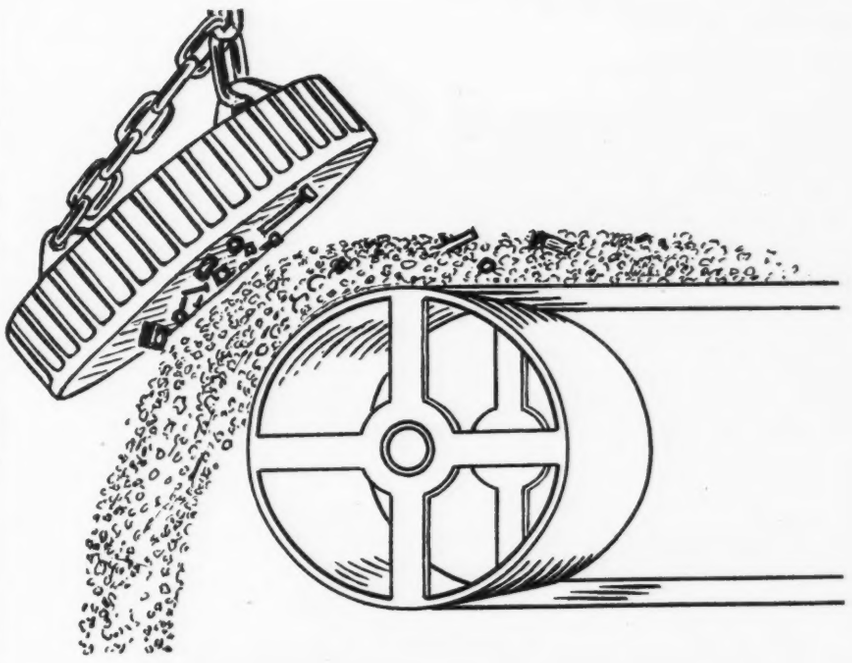
▶ Mount Morgan, Ltd., is raising its capital from the present figure of £350,000 (Australian, £293,000 issued) to £550,000 by the issue of 200,000 £1, cumulative preference shares. The new capital is to provide funds for mine development and equipment, including enlargement of power plant, £92,000; extension of sulphide mill capacity from the present figure of 7,700 tons to 10,500 tons per week; and erection of smelting plant, £60,000. Last year refining and realization of concentrates cost the company £88,973 (Australian) and it is estimated that on the basis of present production smelting at the mine will result in a saving of at least £50,000 (Australian) per annum.

▶ A new discovery of wolfram has been reported from Mount Perseverance, about 54 miles north of Cairns, Queensland. Situated in dense bush country at an elevation of 3,000 ft., the field is difficult of access, but 23 men are already working in small parties, and output is averaging over a ton a week. Further work will be necessary to determine the importance of the discovery.

▶ Bartle Frere, Queensland's newest gold field, is attracting considerable attention, more than 100 areas having been applied for. The field, which lies 10 miles inland from Babinda, is in rugged and lofty mountain country and is difficult of access. C. C. Morton, of the Queensland Mines Department, who made an inspection recently, reports that prospecting conditions are difficult, but that there are possibilities of considerable extensions of the present known reefs, on which "floater" stone on the surface has indicated the presence of fairly high free gold values. Prospecting work at present in progress should determine the importance of the find during the current year.

▶ The option over the leases of Barrier Development, near Broken Hill, recently taken by Willyama Mining, Pty., Ltd., has been abandoned by the latter company.

▶ Two developments of potential importance have lately occurred at Bendigo, Victoria, where, in shaft sinking, New Chum Syncline, N. L., has struck at a depth of 1,008 ft. a reef forma-



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▶AUSTRALIA

tion which is believed to be the reef now being worked profitably by the Central Nell Gywnne Company, 1,400 ft. to the south. The stone is highly mineralized and shows fair visible gold values. Hercules G. M. Company, working on the Sheepshead line, in crosscutting west on the 2,400-ft. level has entered a spurry formation showing some gold, of a type which has been worked in the past with considerable success by companies operating on this line of reef. South New Moon, N. L., in continuing to work the spurry deposits at the 580 ft. level, had a yield of 205 oz. from 40 tons—considerably above average grade. The formation, which is about 50 ft. wide, has up to the present averaged about 6 dwt. per ton.

The new oxidized ore-treatment plant at Mount Morgan, Queensland, Australia, operated by Mount Morgan, Ltd, treats 16,000 tons monthly of overburden material assaying 2.7 dwt. gold per ton. The reserve of oxidized ore is 1,282,000 tons

▶Bulolo Gold Dredging, Ltd., in the half year to Nov. 30 treated 5,158,300 cu.yd. for the production of 64,662 oz., an average of 6.0 grams per cubic yard. Working costs were £178,509 (Australian), equivalent to 8.3d. or approximately 13.8c. per cubic yard. Yardage and gold production were each a little below that of the previous half-year and costs were also a little higher. The necessity during the period of changing the courses of two dredges contributed to this result, a large volume of tailings and overburden having to be dug. No. 5 dredge commenced digging on Dec. 1 and No. 6 was due to start in March, so that costs should show an improvement and output an increase during the current half year. No. 5 dredge will, however, be working under capacity for several months pending the arrival of a new driving motor.

▶G. Ridgeway, the managing director of Lancefield (W. A.) Gold, operating at Beria, W. A., reports that ore in sight is sufficient to last until the end of the year. The ore on the No. 13 level, now being developed, has proved to be disturbed and broken, and the board has commissioned Dr. Moss to make a geological survey of the property and to advise regarding a development policy for the ore lying between No. 13 level and the line of boreholes which showed values at a depth on the underlay of about 700 ft. below that level. Pending the results of that examination, the ore-reserve position is problematical. The mine is at present treating 11,000 short tons monthly for a return of 2,900 oz.

▶Norseman Gold Mines, N. L., operating at Norseman, W. A., had a net profit of £115,717 (Australian) for the year ended Oct. 31, 1937, a 65 per cent increase over the 1936 record. Ore milled totaled 86,862 short tons and gold recovered was 29,121 oz. In addition to ore from its original leases which have reserves totaling 204,000 tons averaging 7.2 dwt., the company is treating ore averaging under 3 dwt. from the recently acquired Iron King leases, and showing a working rofit of 10/- (Australian), or $2 per short ton. It is planned to increase the treatment plant to permit the milling of 5,000 tons monthly from this source, after which, according to estimate, costs and residue losses combined will not be more than 1.5 dwt. per ton. Central Norseman Gold Corporation has optioned a property which is 1½ miles from its main lease. A recently discovered reef is being prospected at a depth of 95 ft., results to date showing average values of 12 dwt. per ton over 24 in.

▶Rothsay Gold Mines, Rothsay, W. A., plans to have its 2,000-ton-monthly concentrator operating by mid-March. Recovery will be by strakes and flotation, the latter process to recover a copper-gold concentrate which will be shipped to New South Wales for smelting. Average grade of ore will probably be 8 dwt. per ton.

▶Triton Gold Mines, N. L., operating near Cue, W. A., reports a net profit of £85,228 for the year ended Sept. 30, 1937. Gold yield was 26,938 oz. from the treatment of 75,825 long tons of ore. Costs at 37/5 (Australian) per ton showed an increase of 3/6 over those of the previous year, attributable to increased wages and stores costs and necessity for increased timbering in part of the mine. Ore reserves at 223,000 long tons, averaging 7.5 dwt., were up 16,000 tons on the year, but do not reflect to its fullest extent the amount of advance development carried out during the year, as there are considerable tonnages of probable ore not included in the reserve. A. A. McLeod is mine superintendent of the company, which is under the general management of Western Mining Corporation.

▶North Kalgurli (1912) Ltd., Kalgoorlie, W. A., reports the location of a new lode at the No. 7 level of the Croesus Proprietary Mine. The lode has been exposed for a width of 53 ft., the average value being 9 dwt. per ton.

▶At the Comet mine, Marble Bar, W. A., where 400 tons monthly of ore averaging 28 dwt. per ton has been treated since February, 1937, winzing below the present bottom level of 130 ft. is exposing ore averaging 35 dwt. per ton over 78 in., the full width of the lode not being exposed.

▶Mount Charlotte, Kalgoorlie, W. A., reports ore reserves tentatively estimated at 1,120,000 tons averaging 5.36 dwt.

FIJI ISLANDS

Emperor Mines Report First Clean-Up

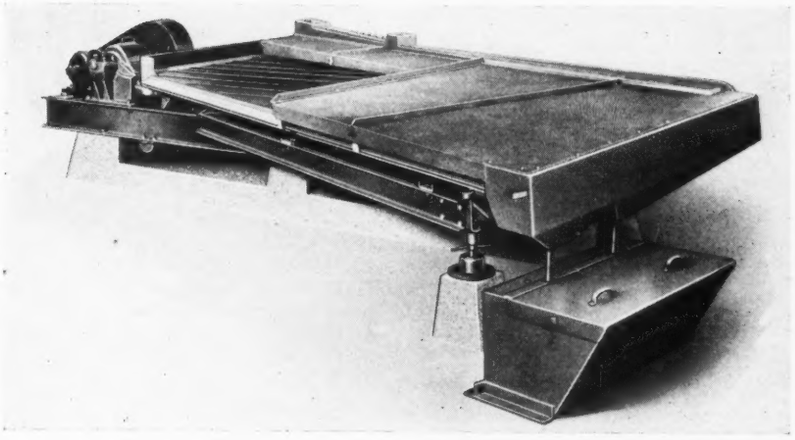
High recovery made in new mill now operating at 12,000 tons' monthly capacity —Deeper development at Loloma continues satisfactory

▶The first clean-up from the new mill of Emperor Mines, Tavua, Fiji., for the period Dec. 26 to Jan. 26, gave a return of 3,044 oz., from 11,426 tons of ore. The recovery represented a return of 5.33 dwt. per ton from heads assaying 6.8 dwt. Tailings assayed 0.63 dwt., showing an extraction of 90.7 per cent, the remainder of the gold not recovered being absorbed in the plant. The mill-head grade was low on account of the deliberate treatment of a large amount of 3- to 4-dwt. ore accumulated from overburdened removal for use in the initial operations of the mill. Rated capacity of the plant is 3,000 tons per week, which has now been reached.

▶Lloma, operating on the same field, has in its fourth clean-up recorded a production of 1,790 oz. from 1,663 tons of ore. Although throughput has not quite reached the mill capacity of 500 tons weekly, recovery at 92.9 per cent shows a great improvement on earlier results. In development work on the 224-ft. level, the south drive has now entered the rich shoot found in the level above, values for the last 107 ft. having ranged from 17 to 44 dwt. per ton over 57 to 84 in. (with the exception of 12 ft. showing low values).

EQUIPMENT NEWS

Concenco Hi-Grader



DEISTER Concentrator Company, Fort Wayne, Ind., announces the development of the Concenco Hi-grader that may be installed in closed circuit with the ball mill and preceding the classifier. The unit is said to remove free gold and gold-bearing sulphides as soon as they are liberated. If desired, a rich concentrate for barrel amalgamation and a leaner direct-shipping concentrate may be made separately. Means are also provided for protection against concentrate theft. Incorporated into the concentrate end of the unit, which possesses the fundamental operating characteristics of the diagonal-deck Deister-Overstrom concentrating table, is a sturdy steel two-compartment launder. This launder is provided with a splitting pan controlled by a lever from outside. The splitting pan may thus be set to cut the high-grade gold concentrate into one compartment, and the shipping-grade sulphide concentrate into the second compartment. Outlets from the compartments are downward through separate pipes into a steel, two-compartment concentrate box. This concentrate box is fastened to the floor and provided with a locked cover. Periodically the cover is taken off and the concentrates are removed for amalgamation or shipment. The deck, with the exception of the tailings area at the motion end, is completley covered with strong steel wire cloth of small aperture, which while preventing access to the concentrate band on the deck, does permit observation of the separation taking place. The operator is therefore able readily to make adjustments that may be required for maximum performance.

Vacuum Cement

A CEMENT for vacuum furnaces which is said to have the feature of not becoming brittle, and which also adheres to any surface and can be re-used indefinitely, was developed by the Westinghouse Electric & Manufacturing Company recently. This cement is solid at room temperature, but at higher temperatures becomes increasing softer. It is said not to deteriorate with use, so it can be reclaimed, the fragments melted together and used again and again. This cement is highly tenacious and will stick to rough or smooth metal, glass, and quartz surfaces to form vacuum-tight joints. In applying it to a vacuum furnace, the cement is smeared over the joints of the cap closing the inner chamber of the furnace. A torch is used to make the compound flow readily and a heated putty knife to spread it. This cement can also be used as a paint by using carbon tetrachloride as a solvent. In this form it can be painted on and a layer of the desired thickness built up.

Electric Concrete Vibrator

SYNTRON COMPANY, of 510 Lexington Avenue, Homer City, Pa., has put on the market a new electric motor-driven, internal type of concrete vibrator to vibrate concrete into place as it is poured. The equipment consists of three pieces—an electric drive motor mounted on two small wheels, a variable length of flexible shafting, and the vibrating tool, which is immersed in the concrete. The electric motor is mounted on small steel wheels and operates on both 110 and 220 volts, single phase, A.C. It has a built-in gear box that increases the driving speed to 7,200 r.p.m. The flexible shafts are metal armored and are available in 7-ft. and 12-ft. lengths that can be coupled together to make up to a maximum length of 31 ft. The vibrating tool is available in two sizes—1⅝ in. and 2⅝ in. in diameter—and consists of

a steel cylinder, inside of which is an out-of-balance shaft rotating at high speed in heavy ball bearings, which sets up a terrific vibration that permeates the mass in all directions. Advantages, listed by the manufacturer, of vibrating concrete at a speed of 7,200 vibrations per minute while it is being poured are: It permits the use of considerably drier mixtures, accomplishes a better bond between successive layers of concrete and between the concrete and its reinforcing, eliminates air pockets and voids, produces a more water-proof, smooth-finished surface and flows the concrete mass into difficult and hard-to-get-at places.

Close-Coupled Motor Pump

GARDNER-DENVER Company, Quincy, Ill., announces its new close-coupled centrifugal motor pump, designed for capacities up to 250 g.p.m. and heads up to 250 ft. at speeds of 1,750 and 3,460 revolutions per minute. The speed depends upon the required capacity and head. Known as Type H, the new pump meets the requirements of all general pumping service. The pump is single suction, having a single-stage inclosed impeller made of standard bronze. The pump and spash-proof motor are mounted together to form a complete and compact unit. An adjustable bearing in the outboard end of the motor is said to compensate for wear between

the clearance spaces in the pump. Because no wearing rings are needed in this type of construction, they have been eliminated, and the usual trouble of re-

placing them will not be experienced. The pumps can be installed in any position—on the floor, on the wall, or on the ceiling and either horizontally or vertically, and may be used for portable and semiportable as well as stationary operations.

Duplex Power Pumps

FAIRBANKS, MORSE & Company, 900 South Wabash, Chicago, Ill., recently announced a new line of duplex power pumps having eight-cover side-pot type fluid ends and inclosed, self-oiling power ends with herringbone gears and large roller bearings. These pumps were designed to meet every requirement for pumping water, oil, or other free-flowing liquids in quantities up to 187 g.p.m. and at pressures up to 1,000 lb. per square inch. They are available as basic pumps, with pulleys for belt drive, or as complete, compact F-M motor-driven pumps covered by a single manufacturer's guaranty. The eight-cover side-pot type of fluid end, with each suction and discharge valve located accessibly in its own valve pot, is said to permit easier servicing than do other types of fluid end construction. Quiet, efficient herringbone gears insure a smooth flow of power, with little vibration, from power end to fluid end. The self-oiling construction employed in the power end assures positive lubrication of all gears, connecting-rod bearings, and crossheads. There is sufficient space between the two removable-gland type stuffing boxes to assure easy access for inspection or servicing, and that no part of the piston rod enters both stuffing boxes, preventing oil from entering the fluid end and water from entering the power end.

Outdoor Oil Circuit Breaker

ALLIS - CHALMERS Manufacturing Company, Condit Works, Boston, Mass., announces a new moderate-capacity outdoor oil circuit breaker of the quick-clearing, non-oil-throwing design, known as the Type OZ-110, that is said to have numerous features. Special interrupting devices called Ruptors are used to give quick clearing of short circuits, low arc energy, low pressure, and minimum of oil deterioration. The breaker is furnished for 600 amp. at 15 kva., with an interrupting capacity rating of 100,000 kva., and is arranged for pole or frame mounting.

The company also announces a moderate-capacity indoor oil circuit breaker of non-oil-throwing construction, capable of wide application to industrial and central station service, known as Type DX-25. Expulsion ports, featured in this breaker, are devices which, it is claimed, hasten arc extinction. Other features include self-aligning, wedge, and finger-type contacts with silver surfaces on main contacts; cast-steel top frame; electrically welded steel tank; one-piece, Bakelain bushings; flat-angle, straight-line-motion type mechanism. The breaker is furnished manually or electrically operated for 600, 1,200, and 2,000 amp. at 15,000 7,500, and 5,000 volts respectively. It has an interrupting capacity rating of 75,000 kva.

BULLETINS

Mill Equipment Catalog. International Combustion, Ltd., Aldwych House, Aldwych, London. Second edition 1938 describes grinding, screening, filtering, and other milling equipment. Pp. 15.

Exhaust Fans. Northern Blower Co., Cleveland, Ohio. Bulletin 1002-3 describes the Norblo direct-driven fan for air-handling or dust-collection purposes. Pp. 4.

Convertible Shovel. Lima Locomotive Works, Inc., Lima, Ohio. Bulletin 11 describes Type 1001 heavy-duty shovel convertible to dragline and crane. Pp. 6.

Roll Crusher. Pioneer Gravel Equipment Co., Minneapolis, Minn. Folder describes the company's Super 40 roll crusher. Form 509 describes the company's vibrating screens and Forms 502 and 560 list features of revolving screens and the Pioneer crusher trailer respectively. Pp. 2.

Handy Estimator for Electrode Quantities. General Electric Co., Schenectady, N. Y. G.E.S.-1749 has handy tables to assist in determining the approximate weight of electrodes needed for various types of welded joints. Pp. 7. GEA-1368-C describes the company's vertical, hollow-shaft induction motors. Pp. 4.

Hardinge Operating Data. Hardinge Company, York, Pa. Bulletin 41 contains informative operating data on the manufacturer's various mills obtained from the mining industry. Pp. 12.

Tantalum. Fansteel Metallurgical Corp., North Chicago, Ill. The booklet has a story of tantalum, and many industrial uses of the metal are illustrated and described. Pp. 31.

Welded Design for Profits. Lincoln Electric Co., Cleveland, Ohio, has issued an attractive brochure intended as an aid in applying electric welding to the design of machines and machinery structures. Pp. 32.

Roller Bearings. Shafer Bearing Corp., 35 East Wacker Drive, Chicago, Ill. Catalog 14 describes the manufacturer's complete line of radial-thrust roller bearings and self-aligning ball- and roller-bearing units for a full range of industrial and machine applications. Price list are given. Pp. 74.

Power Cost. Troy Engine & Machine Co., Troy, Pa. The booklet contains power-cost data on 43 plants employing Troy-Engberg steam engines. Pp. 11.

Direct-Current Motors. Fairbanks Morse & Co., 900 South Wabash Ave., Chicago, Ill. Bulletin 2260 describes the company's line of direct-current motors up to 200 hp. Pp. 7. **Vertical Motors.** Bulletin 1410 describes Type QSZV vertical, hollow-shaft, weatherproof motor. Pp. 3.

Jaw Crushers. Denver Equipment Co., 1400–1418 Seventeenth St., Denver, Colo. Bulletin 3726 describes the manufacturer's 8x10-in. jaw crusher sectionalized for mule-back transportation. Pp. 7. **Heavy Duty Classifier.** Bulletin 3815 describes mechanical advantages of Model D classifier. Pp. 3.

Lathes. South Bend Lathe Works, 520 Niles Ave., South Bend, Ind. Catalog 46 describes and illustrates various type of the manufacturer's 1938 model 9-in. lathes for general use in machine shop. Specifications and prices are given. Pp. 23.

Thermometers. Foxboro Co., Foxboro, Mass. Bulletin 198–1 describes and illustrates numerous recording thermometers for industrial purposes. Pp. 39.

Vanadium in Cast Iron. Vanadium Corporation of America, 420 Lexington Ave., New York, N. Y. An informative booklet describing the improved physical properties of cast irons employing varying amounts of vanadium. Pp. 28.

Tank Heads. Commercial Shearing & Stamping Co., Youngstown, Ohio. Catalog describes the company's range of manufacturing facilities for making tank heads, tank accessories, boiler heads, and stampings. Pp. 27.

Analytical Reagents. Mallinckrodt Chemical Works, St. Louis, Mo. 1937 Catalog lists chemicals and reagents for laboratory use. Pp. 109.

Placer Drills. C. Kirk Hillman Co., 3201 First Ave., South, Seattle, Wash. Booklet describes the manufacturer's placer drill, mounted on caterpillar skids. Pp. 8.

Industrial Friction Materials. Johns Manville, 22 East 40th St., New York, N. Y. Form FM-7A presents data on the company's line of brake linings, and blocks and clutch facings for all types of industrial equipment. Pp. 7.

Automatic Transfer Switches. Automatic Switch Co., 154 Grand St., New York, N. Y. Bulletin presents data on mechanically held automatic transfer switches. Pp. 20.

Pumps. Goulds Pumps, Seneca Falls, N. Y. Bulletin 210 describes single-stage ball-bearing centrifugal pumps. Pp. 7.

Portable Compressors. Schramm, Inc., West Chester, Pa., Bulletin 3815-EL presents descriptive data and prices of new models of the company's "Fordair" portable and stationary compressors. Pp. 11.

Air Circuit Breakers. General Electric Co., Schenectady, N. Y. GEA-2450-A folder describes and illustrates Type AE-1 manually and electrically operated air circuit breakers. Pp. 12.

Glass Filter Cloth. Filter Media Corp., Irvington-on-Hudson, N. Y. Folder describes features and styles of filter cloth made of glass. Pp. 3.

INDUSTRIAL NOTES

William S. Davis, sales manager of the Simplex Wire & Cable Company, Cambridge, Mass., since 1919, and connected with the organization since 1896, has been made a vice-president. His former post is occupied by George L. Roberts, assistant sales manager since 1927, who is succeeded by George A. Grauer, former executive secretary of the wire and cable section of the NRA.

At a recent meeting of the board of directors of the Linn Manufacturing Corporation, Morris, N. Y., the resignation of George Whitman as president and director of the company was accepted with sincere expressions of regret. Mr. Whitman had been associated with the company since its inception. F. R. Van Rensselaer, formerly vice-president, was elected president of the company to succeed Mr. Whitman. Philip W. Sloan was elected vice-president to succeed Mr. Van Rensselaer.

R. A. Gezelius, formerly associate metallurgist of the Naval Research Laboratory, Washington, has just been engaged as a metallurgist by the Taylor-Wharton Iron & Steel Company, High Bridge, N. J. He was recently accorded honorable mention by the American Foundrymen's Association for his work in the field of metallurgy.

Cutler-Hammer, Inc., Milwaukee, Wis., manufacturers of electric control apparatus, announces the moving of its Cincinnati office to the American Building, Central Parkway at Walnut St. M. C. Steffen is manager.

The Roller-Smith Company, 233 Broadway, New York, N. Y., announces the appointment of Arthur G. Miller, Dwight Building, Kansas City, Mo., as its district sales agent for the Kansas City territory comprising the western part of Missouri and the State of Kansas.

F. Lonsdale and **E. A. Pitcher** have been appointed joint managers of Frazer & Chalmers Engineering Works, Erith, England.

The Sterns Magnetic Manufacturing Company, Milwaukee, Wis., manufacturers of magnetic separation equipment, announces the appointment of J. H. Driscoll as the company's representative in Boston, with offices at 34 Lewis Wharf. E. C. KieKhaefer has been appointed chief engineer of research and development in the Sterns organization.

Drilling With Detachable Bits—V

IN THE fourth installment of this article, published last month, the discussion of drilling practice at Western Mine No. 3 was completed and consideration of that at Western Mine No. 4 was begun. The latter is continued in the following paragraphs:

Western Mine No. 4
Continued

The drill-sharpening shop is at the approach to the pit. Sections of drill-steel rods in use are 1¼-in. hollow lugged round, 1-in. hollow lugged round, and ⅞-in. hollow collared hexagon. The steel carries about 0.9 per cent carbon. Only 12½ per cent of the former drill-steel inventory is required for detachable bits.

The sharpening shop is 30 ft. wide and 80 ft. long. Its equipment comprises 2 grinding machines, 4 oil-burning furnaces using air at 14-lb. pressure, 1 electric furnace with pyrometer, 1 tempering furnace with oil bath and indicating pyrometer, 1 tempering furnace with salt bath and indicating pyrometer, 1 drill-rod-threading machine, 1 double emery wheel, 1 electrically driven hacksaw, 1 drill-steel-sharpening machine, together with anvils, quenching tanks, and small tools.

Detachable bits are the four-point, end-hole type. New bits purchased have the following gages: 3-in., 2⅞-in., and 2¾-in. Gage change is ⅛ in. on a 4-ft. run. The smallest bits used are 1¾ in. Large holes are desirable to facilitate springing and loading. There are six regrinds or seven uses per bit purchased. There is a loss in gage of 0.02 in. per foot of drilling. After the bits are sharpened, they are sorted to the nearest ⅛-in. gage. About 16,000 bits are used per month, or 620 per day. One man can grind and gage an average of 138 bits per shift. In the grinding process, bits are first sharpened on the forming wheel and then squared on the gaging wheel. Although no figures are available to show the actual percentage of bits lost, it is known to be almost negligible.

In grinding bits, two men work on each grinding machine. In one shift two men can form and gage 250 Leyner bits or 325 plugger bits. The life of forming wheels is 600 Leyner bits or 1,000 plugger bits, whereas for gaging wheels it is 700 Leyner bits or 1,100 plugger bits. One man can harden and temper 500 Leyner bits or 700 plugger bits.

Plugger bits, which are used for blockholding in the hardest rock, are rehardened after each use. Leyner bits used on 1¼-in. rods in mounted drills require rehardening after either the first or second regrind. An average day's classification of bits in service follows: New bits, 20 per cent; bits reground only, 24 per cent; bits rehardened and reground, 56 per cent.

In the hardening process Leyner bits are heated for 50 minutes in the electric furnace at a temperature of 1,500 deg. F. Plugger bits are heated for 45 minutes at a temperature of 1,450 deg. F. Both kinds of bits are quenched in brine by placing the cutting edges on a punched plate shelf with ½-in. submergence in an open steel tank. A rising current of solution is maintained by means of a circulating pump in the tank. After 60 seconds the bits are removed from the shelf and completely submerged. After cooling, they are removed from the brine and reheated in the oil bath in the tempering furnace at a temperature of 400 deg. F. The Leyner bits remain in the bath for 50 minutes and the plugger bits for 45 minutes. Upon cooling in the open air they are ready for use.

Detachable bits are transported in a steel tray divided into twelve compartments each 7½ by 3 by 4½ in. deep. Round iron handles project 3 in. across each end. The over-all dimensions are 12 x 30 in. The capacity of this tray is 60 bits. Drilling is continuous for three shifts per day. Bits are delivered in trays to the drill by a supply man. The drill operator replaces dulled bits in the tray, which is returned to the shop by a nipper.

Reconditioning Rods—Shanks are forged at 1,800 deg. F. After the forging operation they are normalized by being heated to 1,500 deg. F. and cooled in the open air. They are then given a hardening heat at 1,450 deg. F. and are quenched in cool tempering oil. The ends of the shanks on the 1¼-in. steel are squared on the finishing dolly in the machine sharpener without grinding on an emery wheel. On the ⅞-in. steel, as the final shop operation, they are squared on an emery wheel.

The crew for shanking long drill rods consists of four men—one on the furnace, one on the sharpening machine, and two for handling the rods. This crew can forge shanks on twenty pieces of 1¼-in. lugged steel per hour, or 40 pieces of ⅞-in. collared steel per hour.

In the threading operation, the rods are first sawed off square and smooth. After being heated to 1,800 deg. and upset in the sharpening machine, they are permitted to cool. They are then reheated to 1,400 deg. F. and annealed in specially ground silica or in lime. After being reheated to an estimated 1,500 deg. F. in an oil furnace, they are quenched in cool oil of standard grade for this work. They are tempered in a salt bath at 525 deg. F. for 50 minutes and are then given an interrupted quench by being dipped briefly in water and then cooled in air.

Previous to the adoption of detachable bits, a ten-day test was run in hard ground with two 3¼-in. drills mounted on tripods, during which the data given in Table XII were developed.

Table XIII—Comparative Partial Costs of Drilling. Western Mine No. 4

Item	Conventional Bits Per Bit Dulled	Conventional Bits Per Foot Drilled	Detachable Bits Per Bit Dulled	Detachable Bits Per Foot Drilled
Sharpening, total	$0.0996	[a] $0.0190	.....	.....
Labor	.....	0.0130	.....	.....
Operating supplies	.....	0.0038	.....	.....
Equipment repair supplies	.....	0.0022	.....	.....
New bits, regrinding and rehardening; labor and supplies	.....	.....	$0.125	$0.0181
Rods, reconditioning:				
Threads: Labor, loss in steel, fuel; miscellaneous supplies; repairs to equipment	.....	.....	.....	0.0006
Shanks	.....	.....	.....	[b]
Steel loss, total	0.0529	0.0101	.....	.....
Sharpening loss	.....	0.0029	.....	.....
Broken and stuck in hole	.....	0.0072	.....	0.0072
Transportation and nipping	0.0996	0.0190	.....	[c] 0.0007
Interest on steel inventory	.....	0.0021	.....	0.0003
Interest and depreciation on shop equipment; repairs and depreciation on shop building	.....	0.0008	.....	0.0008
Total	.....	0.0510	.....	0.0277

[a] Exclusive of compressed-air costs.
[b] Costs not segregated for this process during this particular period.
Costs assumed to be the same for both classes of bits.
[c] Estimated.

Table XII—Data on a Ten-Day Test. Western Mine No. 4

Item	Regular Steel	Detachable Bits
Total feet drilled	577.9	748.2
Drilling speed, inches per minute, actual cutting time	21.97	24.66
Feet drilled per bit dulled [a]	2.30	3.33
Gages of bits, in.	2⅝ to 2½	2⅞ to 3

[a] These figures recently increased to 5.24 for regular steel and 6.90 for detachable bits.

Detachable bits thus showed a 12 per cent increase in drilling speed and 44.8 per cent increase in distance drilled per bit dulled.

Comparative partial costs per foot drilled for conventional and detachable bits are given in Table XIII. The costs for detachable bits are for a recent six-month period; the figures for conventional bits are for a similar period immediately preceding the adoption of detachable bits.

Western Mine No. 5

Summary—Hot-milled conventional bits on regular steel are used for all routine drilling because the indicated cost per foot drilled is lower than with detachable bits.

The following factors at this mine are favorable for conventional bits:

1. The sharpening shop has long been noted for fabricating conventional bits of a highly superior quality.
2. Sharpening costs for conventional bits are exceptionally low.
3. Distribution costs for conventional bits are well below the average for underground metal mines.
4. The cost for new detachable bits is excessive because of their short life as reflected in total feet drilled per bit. This is the result of drilling in extremely abrasive material, which rapidly destroys the bit.
5. Sharpening costs for detachable bits are higher than the average for metal mines.
6. Drilling speed is greater with hot-milled conventional bits.
7. Penetration per bit dulled is less with detachable bits.

Factors favorable for detachable bits are as follows:

1. Lower steel-replacement cost.
2. Low distribution cost.
3. Low interest and depreciation charges for sharpening-shop equipment and steel inventory.
4. Reduction in loss of miners' time account transporting steel (not shown in detailed costs).

The rocks drilled comprise sedimentary and intrusive rocks, soft oxide ore, and siliceous massive sulphide ore. There are various phases of contact metamorphism and limestone replacement. These rocks vary from soft and sticky to hard and extremely abrasive.

Operating Practice — All routine drilling at this mine is wet and is performed with conventional bits on regular steel. A unique feature of the sharpening process adopted in October, 1934, is a combination of forging and hot-milling. The rock drill machines required for the wide range of drilling conditions are 3¼ to 4-in. drifters, 2¾- and 3-in. stopers, and 2½- and 2⅝-in. jackhammers. The air pressure at the compressor is 90 lb. and at the drills it is 77 to 85 lb. The average depth of holes is approximately 6 ft. A sharp bit has an average penetration of 1.80 ft. in dense, siliceous sulphides. The sections of steel in use are 1-in., 1⅛-in., and 1¼-in. round for drifters; 1-in. and 1⅛-in. round, hexagon, or quarter octagon for stopers; and 1- and 1⅛-in. hexagon for jackhammers. The 1¼-in. steel for drifters is now obsolete and is not being replaced. The shanks on all these various sections are lugged round.

Bits have a 90 deg. angle between cutting faces. Clearance tapers are 5 deg. and 14 deg. The gage change for a 15-in. drill run is ⅛ in. for the larger bits and 1/16 in. for the smaller bits, as given in Table XIV.

A 24-in. drill run is being considered for drills with automatic feed.

The drill-sharpening shop is near the collar of the supply shaft. The equipment consists of 7 sharpening machines, including one spare; 7 pedestal punches; 6 furnaces, using gas at 12-lb. and air at 90-lb. pressure; 1 gas-fired lead bath with pyrometer; 4 hot-millers; 1 large furnace for normalizing; 1 double emery wheel; 1 water quenching tank; 1 oil quenching tank with water jacket and circulating pump; and steel trucks with revolving racks with four compartments.

The estimated forging temperature for bits is 1,800 to 1,900 deg. F. Bits are hot-milled on the same heat as for forging. The accuracy of gaging by this method is shown by the established tolerance, which is less than 1/64 in. for this process. The wear on the milling wheel is slight.

For hardening, bits are heated in a lead bath in a cast-steel pot. The temperature of the lead is maintained between 1,425 and 1,440 deg. F. by means of an indicating pyrometer and manually controlled gas burner. It requires 1½ hours to heat the lead to the proper temperature. The drill steel is placed in a circular steel turret, which moves in the lead pot at the rate of 30 revolutions per hour. The turret holds 16 pieces of steel. Since each piece of steel remains in the bath for one revolution, or 2 minutes, the capacity per hour is 480 pieces. The submergence of the bits in the lead is ⅞ in. To prevent oxidation, the molten lead is covered with a layer of charcoal 1 in. to 1¼ in. deep. The weight of lead in the pot is 1,100 lb. The replacement lead averages about 11 lb. per day. Bits are quenched by complete submergence in a rising current of cold water.

Shanks are forged at 1,800 to 1,900 deg. F. (estimated), reheated in a gas furnace to 1,500 or 1,550 deg. F., and hardened by quenching in a standard oil for this purpose.

The entire drill steel in service is normalized at regular 18-month periods by heating in the normalizing furnace to 1,450 deg. F. and cooling in the open air. Bits and shanks are then rehardened as described in the foregoing.

An average of 1,800 pieces of steel are sharpened per day. This requires a crew of eight men on sharpening and two on hardening. In addition, there is one supervisor. The output per sharpening machine per shift is 450 bits. This high rate is possible on account of finishing the bits on the hot-milling machines.

Comparison of Hot-milled Bits with Forged Bits—The principal advantage of the combination forging and hot-milling over straight forging lies in the reduction in sharpening-shop expense. A disadvantage is the increased loss of steel. Labor is reduced 15 per cent, or $0.0074 per bit sharpened; the steel replacement is increased $0.0053. This makes a net advantage for hot-milling of $0.0021, or approximately ⅕ c. per bit sharpened. The comparative statistics shown in Table XV indicate a 7 per cent increase in penetration for the hot-milled bit and approximately the same drilling speed.

(To be continued)

—Excerpted from United States Bureau of Mines Information Circular No. 6951, written by McHenry Mosier.

Table XIV—Gage Changes, Drilling With Regular Steel, Western Mine No. 5

Drill	Length		Bit Gage		
	Feet	Inches	1¼-In. Steel	1⅛-In. Steel	1-In. Steel
Starter	2	6	2 7/8	2	1 7/8
Second	3	9	1 15/16	1 7/8	1 3/4
Third	5	0	1 13/16	1 3/4	1 5/8
Fourth	6	3	1 3/4	1 5/8	1 9/16
Fifth	7	6	1 11/16	1 1/16	1 1/2

A 24-in. drill run is being considered for drills with automatic feed.

Table XV—Hot-Milled Bits Versus Forged Bits. Western Mine No. 5

Item	Forged Bits	Hot-milled Bits
Inches drilled	2,866	3,066
Inches drilled per minute	7.07	7.03
Inches drilled per bit dulled	20.18	21.59
Inches loss in gage per foot drilled	0.074	0.072
Average bit gage, inches	1⅜	1⅜
Steel loss, inches reduction in length of drill steel per bit sharpened:		
Wear in drilling	0.07	0.07
Sharpening	0.26	0.43
Total	0.33	0.50